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THE REINFORCED-CONCRETE BRIDGE ACROSS THE RHONE AT PYRIMONT, FRANCE.

On the upper reaches of the River Rhone in eastern France, at the village of Pyrimont, there has recently been built a reinforced-concrete bridge of such exceptional design as to be notable even in this day of reinforced-concrete bridges. We publish herewith a description of the work, abstracted from the "Schweizerische Bauzeitung" for Dec. 7, 1907.

The necessities of traffic have long demanded a bridge at or near this point, but the peculiar conditions which have governed the design have retarded any active effort until the present bridge was started. In the first place the banks of the river here are at least 100 ft. above mean water, thus necessitating a high level roadway. The traffic, too, while requiring some sort of a crossing, is of the light vehicular nature common in most rural districts, and calls for only the narrowest of roadways. The Rhone in this district has a very rapid current and runs over a bottom made up of a very light sand and gravel so that pier construction is costly and difficult. Add to this the lack of funds in a country community and the beauty of the surrounding landscape which demands the most artistic treatment possible and the problem which confronted the engineer will be appreciated.

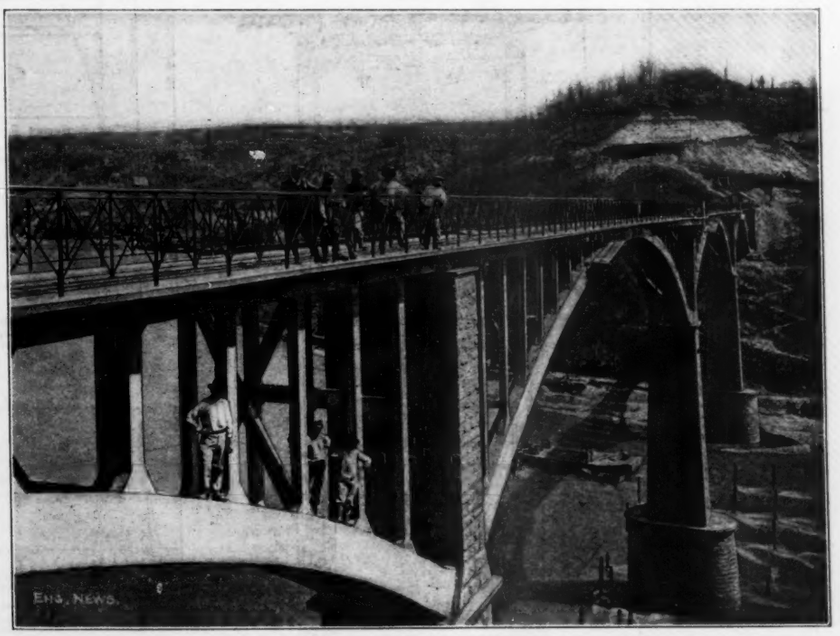

FIG. 1. VIEW OF PYRIMONT BRIDGE LOOKING TOWARD HAUTE-SAVOIE OR THE EAST.

At first sight a suspension bridge seemed to offer the best solution. It could be light, and therefore comparatively inexpensive; and it would easily carry a high level roadway without the use of the objectionable mid-river piers. However, its appearance would be open to considerable criticism, so the officials in charge of the project decided not to call for a suspension bridge but to open a competition in which only the general conditions of the project should be stated, the engineer to provide his own design. Of the many designs submitted under this competition the far greater part were for some form or other of suspended steel structure, but two reinforced-concrete bridges were submitted, both by engineers of the Hennebique system of reinforced-concrete construction. Of these two, one by M. S. de Mollins was accepted by the commission appointed to judge the design. It was approved by the Minister of the Interior on Feb. 11, 1905, and the contract awarded to a company called "La Grenobloise" for the sum of $36,000. Future additional expenses brought the total cost of the bridge up to $42,400.

From previous knowledge of concrete bridges it would seem that they would be the least desirable to fulfil the requirements here imposed, but by a very novel design M. de Mollins has solved admirably the problem. The bridge is about 612 ft. long and consists of three and one-half reinforced-concrete arch spans resting on tall, slender stone masonry piers. Each full arch has a clear span of 169 ft. and a rise of 25 ft., with a distance of 177.2 ft. between centers of piers. It is on the high level required, has only one pier in the river bed and that in shallow water, is extremely graceful and of low cost. Although massive concrete would have been entirely out of place here, the extreme narrowness of the roadway and the skeleton character of the arch construction have made the use of reinforced concrete quite appropriate.

The roadway for the greater length of the bridge is only 7.2 ft. wide, with two 2.5 ft. sidewalks, but at two of the piers there are placed cantilevers on which the floor is carried so as to allow for a distance of 33 ft. an enlargement of the roadway to 14.8 ft. with two 1.2 ft. sidewalks, thus making room for the passage of two vehicles.

Each arch ring consists of two no-hinged reinforced-concrete ribs spaced 7.5 ft. c. to c. and 1.3 ft. thick for most of their length, but at the haunches they widen out to 2.5 ft. Each rib has a depth of 3.3 ft. at the spring and 2 ft. at the crown. They are tied together, as shown in Figs. 3-5, by an 8-in. slab along the intrados at the spring and by a 6-in. slab along the extrados at the crown, with cross-beam braces at the intermediate panel points. The reinforcement consists of a row of four 1-in. rounds along the intrados and four 1⅛-in. rounds along the extrados with a supplementary row of four rounds opposite that face of the rib where the connecting slab is placed. That is, there are eight 1⅛-in. rounds along the extrados near the haunch and eight 1-in. rounds along the intrados at the crown. The connecting slabs are reinforced in both directions with 3-16-in. rods spaced about 1 ft. c. to c. At the piers the ribs and the connecting slab extend through the stone masonry, thus making a continuous concrete arch structure from one abutment to the other. Unfortunately, there is no drawing available showing a plan view or an enlarged elevation of this construction, but Figs. 3-5 show the arch ring reinforcement and detailed sizes.

The floor system is a reinforced-concrete slab cut at 28 places in expansion joints filled with bitumen, but continuous over the piers. The floor is carried on transverse floor beams resting on small spandrel columns footing on the

arch ring and braced and counterbraced as shown in the half-tones. These columns, built according to the Hennebique vertically reinforced-concrete system of column construction, are about 8 ins. square reinforced at each corner with a 11-16-in. rod. This reinforcement is well tied into that of the arch ring and counterbraces, as shown in Fig. 4. The roadway is further supported by longitudinal stringers running between floor beams which do not show in side elevation or plan on any of the drawings, but which may be seen in vertical section in Figs. 3-5. The floor slab is 4 ins. thick where the stringers exist but near the crown the floor and the connecting slab are one in a slab 6 ins. thick.

The widened portion of the roadway at two of the piers is formed by cantilevered beams over the pier and from the first three spandrel columns, the outer fascia stringer following in a curve the line of the enlarged roadway. A detail of this cantilever shown in Fig. 7 is self-explanatory.

In order to get as great a weight as possible into the piers so as to make them stable in the strong current—especially during construction—it was decided to build them throughout of cut stone masonry. They are 8.2 ft. wide at the haunches of the arches, a point about 87 ft. above mean water, and are battered on both sides to about 1 in 9, with a bottom width longitudinal to the bridge of about 18.5 ft. Pier No. 1, on the Haute Savoie side of the river, was built in open caisson excavated out of the sand and gravel bottom. The footing is of concrete reinforced with a network of old rails. Pier No. 2, in the middle of the river, was built with a pneumatic caisson, but on account of the violence and height of the water it became necessary to drive an enclosure of piles outside the limits of the caisson. The footings descend to about 33 ft. below mean water. Before the masonry was started at the bottom about 6,600 lbs. of cement grout was pumped into the sand and gravel there to make a more solid foundation.

The construction of the arches did not present any especial difficulty. The concreting was started simultaneously at each haunch in order to avoid any unequal pressures on the piers. Instruments reading to tenths of millimeters were placed at each crown to measure the movements there, but the maximum rise measured was but two millimeters (0.08-in.). The entire arch rib system was finished before work was started on the superstructure. It was found that building these upper works from one end towards the other caused a rise of about 3-16-in. at the crown of the arch ring next beyond the one loaded. To overcome this tendency to rise the crown affected was loaded with temporary weight which served to keep the proper curve in the arch ring until the concrete had been placed for its whole length.

and each carrying at the skewback [illegible] a fan-shaped system to the arch rings. [illegible] the arch over the deep and swift channel, the centering was supported by a truss system resting in the river on two closely driven pile bents and at the piers on beams previously laid up in the stone masonry. The entire centering was entirely satisfactory and no settlement of appreciable amount occurred during the construction. This is, of course, partly due to the extremely light dead load of the bridge.

The computations for the arch ring were made for a temperature variation of ± 18° F. Under the strain due to this change in temperature and with an assumed live load of 6.5 ton wagon or a static live load of 40 lbs. per sq. ft. there is a maximum compression in the concrete of 480 lbs. per sq. in. and a maximum tension in the steel of 15,000 lbs. per sq. in.

The work was carried on under the direct supervision of the designer, M. de Mollins, with the inspection of the engineers of the government. Under a law in force in France the general government shared the expense of the construction with the commune or township of Challonges in which the station of Pyrimont is situated. The bridge was tested and put in service last summer and has proved satisfactory in every way.

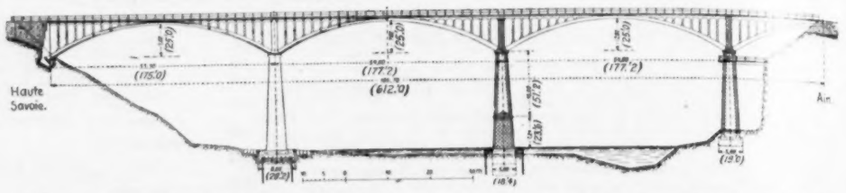

FIG. 2. REINFORCED-CONCRETE ARCHES ACROSS THE RHONE AT PYRIMONT, FRANCE.
(Span = 169 ft. Rise = 25 ft.)

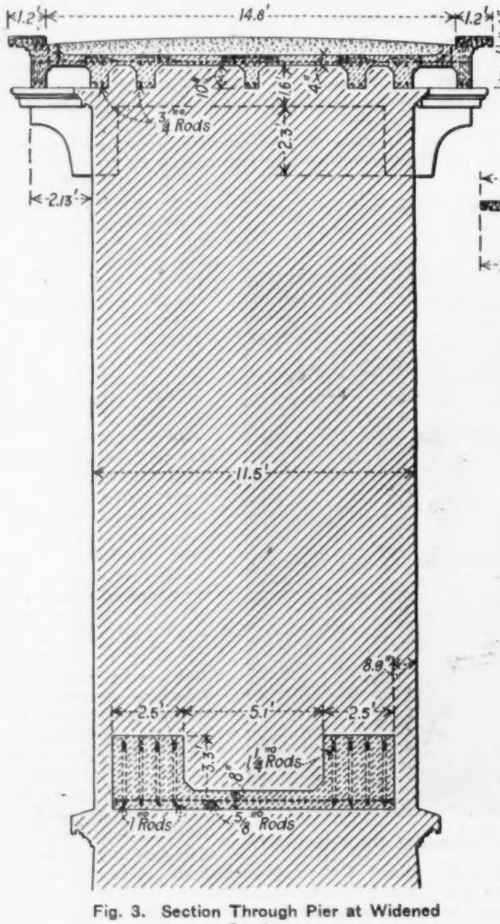

Fig. 3. Section Through Pier at Widened Roadway.

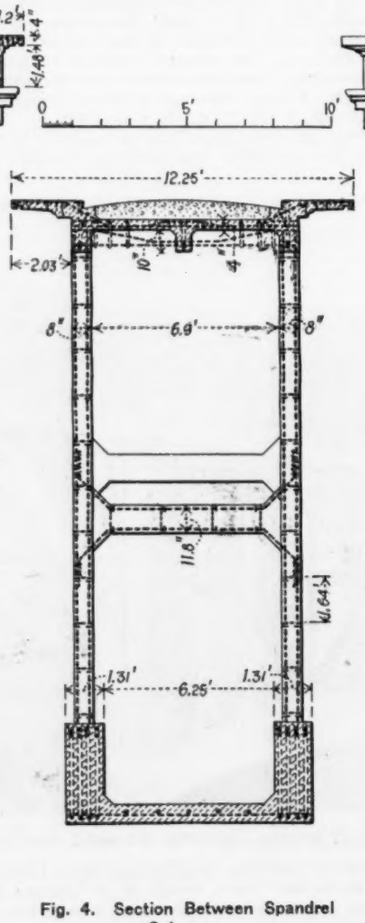

Fig. 4. Section Between Spandrel Columns.

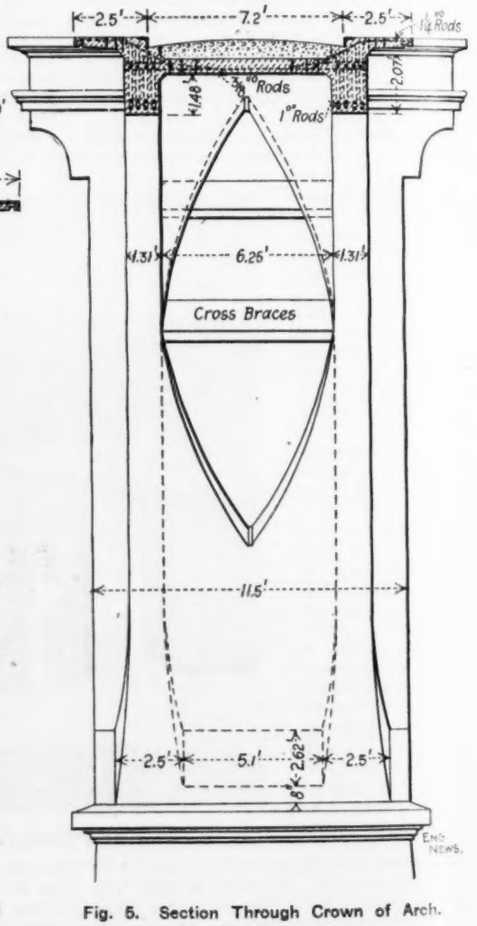

Fig. 5. Section Through Crown of Arch.

GRADE AND CURVE IMPROVEMENT WORK ON RAILWAYS.*

1. TRACK ELEVATION AND DEPRESSION IN CITIES.

There should be a superintendent of construction in complete charge of the work. To him should report the following officers in charge of the various branches of the work. The engineers, having charge of the contract work and giving lines and grades; the roadmaster, in charge of earthwork and track work; the engineer in charge of masonry and bridges; the yardmaster, in charge of engines and switching; the trainmaster (with a despatcher), in charge of the operation of traffic over the territory covered by the work. If the proportions of the work allow, every person connected with this organization should be relieved from all other duties relating to the operation of the road.

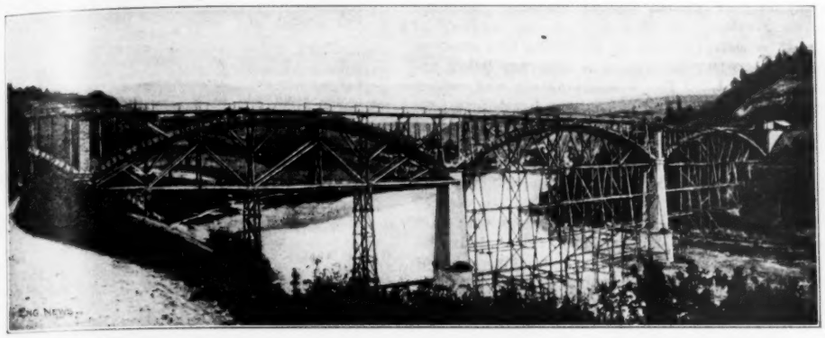

FIG. 6. VIEW OF PYRIMONT BRIDGE DURING CONSTRUCTION, SHOWING CENTERING.

The railway company should handle with its own force all work which may interfere with the operation of the road, such as track raising or lowering, filling and excavating, handling and laying tracks, moving switches and putting in bridges under traffic. All other work which can be done without any interference with the operation of the railway should be let by contract, both for economical and political reasons. This consists of street work and concrete work when practicable.

As far as practicable, all earthwork should be handled by machinery, that is, loaded by steam shovels and unloaded by plows, handled by cable unloaders, and moved by spreaders. The best material to use for filling is sand.

Bridge work, both railway and highway, must ordinarily consist of temporary bridges, to be replaced by permanent bridges after tracks are elevated or depressed.

Water, sewer and gas pipes, electrical conduits and wires should be taken care of and the work of moving them should be done by the companies owning them, whether or not the work is paid for by the railway company.

2. IMPROVEMENT WORK OUTSIDE OF CITIES.

This work groups itself, like all railway enterprises, under location, construction and operation. The committee is concerned principally in the best methods of carrying out construction. In order to do this, however, it must consider both location and operation. It must be assumed that the location is the best the country will allow and circumstances permit, and that it has been fully completed, including purchase of right-of-way; that whatever grades or curves are determined upon, they are established and will not be changed during construction.

There is often a strong tendency to hurry on to construction before enough time and thought is given to location. It must be kept in mind that the real object of it all is to haul tonnage over the road with the least work and in the shortest time.

REVISION OF ALINEMENT WITHOUT CHANGE IN GRADE.—In cases where the alinement only is being revised, there is very little interference with traffic on the old line, such interference consisting mostly of provisions for crossing the old line with material; temporary supports for existing structures, where the new line closely approaches the old, at bridges or other openings; and necessary restriction of speed to a safe limit on the newly constructed track or old track being shifted to a new line, under traffic.

REVISION OF GRADE WITHOUT SUBSTANTIAL CHANGE IN ALINEMENT.—On single track this work naturally consists in cutting down the grade of the track at summits and raising it in depressions. A very important feature of it is the provision necessary for taking care of the traffic of the line while the work is in progress. Where practical this can best be done by the construction of a temporary traffic track, so located as to separate the traffic of the line from the grade-reduction work. It may be impossible to make it entirely separate, so that there will be some points at which it will be necessary to raise or lower the main track under traffic. The amount and importance of the traffic on the line will determine the expense which will be justified in providing a temporary traffic track, but in general an entire separation of the traffic from the track on which construction work is being done, is very desirable. On some occasions it is practical to shift the alinement so that the new line will be far enough away from the original line to permit of the construction of new cuts and fills on the revised grade without interfering with the traffic.

The best practice in making grade reduction on double track is to operate short sections of the line as single track while grading is being done for the other track. The sections would naturally be those between two points where the new grade line connects with or crosses the old. On single track where second track is being constructed coincident with grade reduction, it may be practicable to prepare the roadway for the additional track on the adopted grade and to construct this track and place the traffic on it. After this the original track is taken up and grade of same revised. In this way interference with the traffic of the line is reduced to a minimum.

IMPROVEMENT IN BOTH GRADE AND ALINEMENT.—In many cases on single track the new alinement crosses the old one, and the new grade may or may not coincide with the old at points of crossing. The methods of the construction of those portions of the line which are entirely separate from the old line are those in common use for the construction of an entirely new line. The handling of traffic at the time of its introduction on the new line, particularly at the point where the new line crosses the old, is a matter which must necessarily be worked out for each case.

On double track, it may be found practical to operate portions of the line as a single track while grading the other track. Such of the work as is entirely separate from the old location can be prosecuted without interference with the traffic. On single track where second track is being constructed in connection with grade and alinement revision, the methods of handling work covered by this heading are similar to those already described, except that construction of the second track makes it possible to more readily shift the traffic from the old track to the new.

DRAINAGE.—The first thing and the last thing in grade-reduction work is taking care of the drainage. First the natural water courses should be looked after and ample waterways provided, so that destructive high waters may not injure the new work. This is also of the highest importance to the permanent work. The original heavy grade undulating railways dip deep down into the valleys and in very high waters the flood line has often overtopped the rail without serious damage. The reduced grade line is always high above the valley, and unless enough waterway is given to carry the extreme floods the waters will at first be dammed back and then go through the embankment, taking more or less of it along with them. As far as practicable also surface drains, large and small, should be made in advance of the making of the roadbed. The last thing is to provide ditches in the cuts. As the slope of these ditches is much less than the slope of the original ditches, they must have a correspondingly greater area, and be furnished with uniform slope and smooth perimeter.

The growing of shallow, water-holding potholes in the roadbed is a disease which becomes worse and worse as time passes and traffic becomes more dense. In the original roadbed the traffic was at first light and kept gradually increasing as the roadbed became seasoned; under these best conditions these potholes have come. How much worse these evils may develop after the dense traffic is thrown at once on the green roadbed, time alone will tell in each case. The only antidotes that can be named are most of all thorough drainage from the first, the crowning of the roadbed (high in middle, low at sides); a cushion of best available material between earth and ballast; and when potholes do appear, their prompt and complete drainage through shallow transverse drains, provided with tiling and filled with broken stone.

CROSSINGS.—The separation of grades, both railway and highway, should be included wherever it is practicable. The diversion of different lines of concourse from a common level to over and under-grade not only avoids many mishaps of colliding, but prevents untold delays in carrying out the work of grade reduction, and its good effects will be felt as long as operation continues.

STRUCTURES.—The replacing of temporary structures, such as wooden bridges, with permanent bridges of concrete and steel, deserves careful consideration. When grades are reduced to 0.3 and 0.4%, as is usually now done when such work is undertaken, the physical limit of grade reduction has been closely approached, if not attained, and the roadbed is in its final place. By the use of concrete arches and girders, with ballast-carrying floors, the roadway can be made nearly continuous across fills, and the trouble and expense of incessant breaks running on and off bridge approaches disappear from operation. This is especially important in this class of work, where the fills are so often high and always loose, and where subsidence is both great in amount and long in time.

TRAFFIC.—The keeping of the traffic of the road apart from the work of grade reduction is most urgent of all during the time work is going on. While it does not have the far-reaching effects of the preceding considerations in the future operation, yet for the present, while work is in progress, no railway which has traffic dense enough to justify reduction of grades can afford to let the two kinds of service conflict with one another on the same tracks. When the excavation and embankment are within moderate reach of each other, it is best to provide a new system of tracks for the grade-reduction work. If they are so far apart that miles of track must be used jointly, then separate tracks for the terminals of grade-reduction work should, by all means, be laid.

Where it can be done, an entire new line may be located along the old one. Often a temporary roadway may be built to carry the traffic outside the zone of interference with the work. Again, the new location may be alongside the old line, so as to give the traffic room to pass. The working track may sometimes be taken over or under the traffic-carrying track, when crossings are necessary.

EARTHWORK.—The light work, the drainage ditches, small cuts, ends of large excavations, most of the preparatory work, and all work with short haul can usually best be done with teams. In longer hauls and heavier work there is a field for the use of small cars, with a variety of ways for loading, but for the vast excavations which must be made in grade reduction, the only means which can seriously be considered are large steam shovels and other such excavators, with all necessary appliances. At the present time the main task is to get the material away from the shovel; the loading is far in advance of the hauling capacity. Ample shrinkage should be put on both crown and sides. This subsidence, greatest at first, grows less and less with time, and in a few years may cease.

ORGANIZATION.—Whether the work is done by contract or by the railway forces, there must be one man in responsible control of the entire work, whom we may call the superintendent of construction. Directly under him there should be others, whom we may call supervisors, each of whom should have charge of a division of the work, which is complete in itself, and can be handled by itself, independent of the other divisions. Under the supervisor there should be as many foremen as necessary to direct the gangs. There should be one or more on excavation, one or more on embankment, a track foreman, and a repair foreman whose duty it is to go over the equipment every day and to keep it up in the best condition, making running repairs.

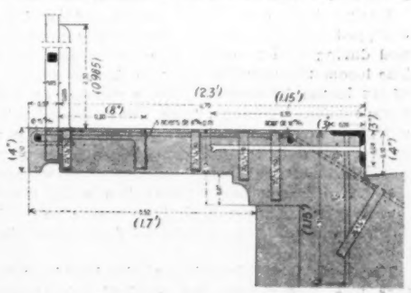

Fig. 7. Enlarged Section Through Cantilever Sidewalks.

Each man in direct charge must have authority over the men to compel them to work or to cease working, must settle all conflicting claims to position, right of

*Abstract of the report of the Committee on Roadway, presented at the annual meeting of the American Railway Engineering and Maintenance-of-Way Association, held at Chicago, March 17-19, 1908.

track, etc., and especially devote his constant attention to securing quick movement in all parts of the plant. Equally important is the general layout and direction of the work. The relative position and order of the successive steam shovel cuts, the position of each loading track, and all features of the work should be determined in advance, and the carefully wrought out plan followed to the end. This should be done by the man in responsible charge of the work, by whatever name or title he may be known. This careful planning in advance insures the saving of time and money. The simplest organization is the best for carrying on the work.

CONCLUSIONS.—The following rules of practice are recommended:

1. Establish the lowest gradient and lightest curvature which physical conditions and the present and prospective business of the road will admit.
2. Complete the location entirely before entering on the work of construction.
3. Attend, first of all, to surface and waterway drainage, and last to the roadway drainage in excavations.
4. Separate the grades of railways and highways, wherever practicable.
5. Eliminate temporary bridges, etc., by the substitution of permanent structures in concrete and steel, wherever it can be done, having in view the formation of a continuous roadway on ballast.
6. Do all light, short haul and preparatory work with teams or other light working plant.
7. Provide separate tracks for work and traffic, wherever it can be done.
8. Have a well-defined plan for conducting heavy excavation before starting work.
9. The simplest organization is the best. Some one man should be in responsible charge of the work, with a staff of engineers under him, and enough supervisors to cover the work, who have full control of men, material and means for each section, with foreman and gangs everywhere needed.

COST OF EARTH WORK ON THE BELLE FOURCHE DAM, SOUTH DAKOTA.*

The Belle Fourche Dam, being built by the U. S. Reclamation Service across Owl Creek, a small tributary of the Belle Fourche River, near Belle Fourche, S. Dak., has a length of about 6,500 ft. and a maximum height of 115 ft. The earth body is being constructed of a heavy adobe clay, intermingled with occasional layers of shale. The material is deposited, wet, and rolled in 6-in. layers, all stones exceeding 6 ins. in diameter being removed before rolling.

The total earth volume of the Belle Fourche Dam is 1,600,000 cu. yds. Of this quantity the contractors placed during the years 1906 and 1907 a total of 504,000 cu. yds., approximating about 32% of the entire amount of required excavation. The material placed in the dam during this period was carried on by two simultaneous processes: (1) that in which steam shovels, engines and dump cars were used; (2) that in which dump wagons and elevating graders drawn by horses or traction engines were used.

During 1906, one 75-ton Vulcan steam shovel equipped with a 2½-cu. yd. dipper was employed, and during 1907 two such shovels were operated. The locomotives serving the two shovels consisted of six 18-ton Davenport dinkeys running on 3-ft. gage tracks. Each of these locomotives hauled a train consisting of ten "Western" dump cars having a capacity of 4 cu. yds. each. During 1906, the material was hauled for an average distance of about one mile against a 2% maximum grade. During 1907 there was a one-mile down-grade haul, the maximum down-grade being 4%.

The material as dumped on to the dam from the cars was spread into the required 6-in. layers by 4-horse buck scrapers, followed by a 6-horse road leveler, the locomotive tracks being arranged so as to require spreading for a distance of 50 ft. in each direction from them. The tracks were shifted in position 10 ft. after the deposition of every third layer of material. The sprinkling was done by means of hose attached to iron pipes running from a stationary pump at a reservoir constructed on Owl Creek above the dam site to temporary elevated reservoirs at the ends of the dam. The pipes ran over the dam, so that the water for sprinkling was supplied by pressure from the pump when it was being operated and from the elevated reservoirs at other times. The rolling was done by means of a 32-HP., 21-ton traction engine, supplemented with a 12-ton Kelley Springfield road roller. These traction engines were very efficient and four of them were in use on the job.

Two "Western" elevating graders of standard size, either drawn by 16 horses or by 32-HP., 20-ton tractions, were used in connection with the construction with graders. These graders served 3-horse "Aurora" dump wagons, having a capacity of 1.1 cu. yds. of material measured in excavation. Twenty-four dump wagons of this type were required to serve the two graders, the average length of haul in this case being approximately 1,300 ft. The sprinkling and rolling were accomplished in the manner heretofore outlined for the steam shovel work. The spreading was done by means of a 6-horse road leveler.

The cost of labor and material during the two years operation was unusually high. Common laborers received from $2.25 to $2.50 for 10 hours' work, while the labor of horses was paid for at the rate of $1.15 per day. Coal delivered at the works cost $10.50 per ton. The cost of placing the material has been separated into the following divisions: Excavation, Hauling, Main Track, Spreading, Rolling and Watering for the steam shovel work, and into the same headings, except Main Track, for the grader work. Each of these subdivisions is in turn subdivided into Labor, Depreciation and Repairs, and Supplies. The cost of superintendence, including the proportional railroad fares of employes, light, heat, salaries of general superintendent, engineer, bookkeeper, timekeeper, blacksmith, machinist and shipping clerk, and building rental, has been charged into the labor account and amounts to about 3.3 cts. per cu. yd. for the steam shovel work and 2.2 cts. per cu. yd. for the grader work. The charge for depreciation and repairs covers machinery and equipment, and is based upon the estimated salvage at the end of the work, as well as on all cost of repairs. The charge against supplies covers the cost of coal, oil, powder, etc.

The specifications provide for extra payment for trench excavation, stripping borrow and gravel pits, trimming the embankment and excavating for structures, which relieves the general cost of the earth embankment of numerous expensive incidental items. The scarcity of water in the locality of the dam is an item of considerable cost to the contractor. For the proper execution of the work, the contractor, in addition to constructing the reservoirs for sprinkling purposes, had to sink two artesian wells, each 1,430 ft. deep, to obtain suitable water for general boiler use. This cost has, however, been properly distributed among the various items. Flood protection at Owl Creek, which will be required during the coming season, is not included in the tabulation, and will add to the cost of the entire embankment from 1½ to 2 cts. per cu. yd.

The costs of steam shovel work and of grader work are shown in Tables I. and II., respectively.

TABLE I. COST OF STEAM SHOVEL WORK ON BELLE FOURCHE DAM EMBANKMENT, FOR 1906 AND 1907.

(Yardage for both years = 305,000 cu. yds.; daily average per shovel = 951 cu. yds. per day of 10 hours.)

Distribution of costs.		Cost per cu. yd.
Excavation—		
Labor	$14,215.01	$0.047
Depreciation and repairs.	8,892.81	0.029
Supplies	8,189.94	0.027
Total	$31,297.76	$0.103
Hauling—		
Labor	$11,228.17	$0.037
Depreciation and repairs..	9,285.76	0.030
Supplies	10,738.00	0.035
Total	$31,251.93	$0.102
Main Track—		
Labor	$3,633.29	$0.012
Depreciation and repairs..	3,991.96	0.013
Total	$7,625.25	$0.025
Spreading—		
Labor	$36,052.14	$0.118
Depreciation and repairs..	683.83	0.002
Total	$36,735.97	$0.120
Rolling—		
Labor	$1,891.63	$0.006
Depreciation and repairs..	1,361.03	0.004
Supplies	2,176.06	0.007
Total	$5,428.72	$0.017
Watering—		
Labor	$4,143.20	$0.014
Depreciation and repairs..	3,611.69	0.012
Supplies	1,243.43	0.004
Total	$8,998.32	$0.030
Grand totals—		
Labor	$71,163.44	$0.234
Depreciation and repairs..	27,827.08	0.090
Supplies	22,347.43	0.073
Total	$121,337.95	$0.397

TABLE II. COSTS OF GRADER WORK ON BELLE FOURCHE DAM EMBANKMENT FOR 1906 AND 1907.

(Total yardage for both years = 199,000 cu. yds.; daily average per grader = 556 cu. yds.; 10 hours = 1 day.)

Distribution of costs.		Cost per cu. yd.
Excavating—		
Labor	$9,368.66	$0.047
Depreciation and repairs..	3,407.65	0.017
Supplies	2,307.56	0.012
Total	$15,083.87	$0.076
Hauling—		
Labor	$25,006.40	$0.126
Total	$25,006.40	$0.126
Spreading—		
Labor	$3,276.98	$0.016
Depreciation and repairs..	250.30	0.001
Total	$3,527.28	$0.017
Rolling—		
Labor	$1,631.99	$0.008
Depreciation and repairs..	1,052.82	0.005
Supplies	1,566.39	0.008
Total	$4,251.20	$0.021
Watering—		
Labor	$2,247.89	$0.011
Depreciation and repairs..	2,103.47	0.011
Supplies	594.25	0.003
Total	$4,945.61	$0.025
Grand totals—		
Labor	$41,530.92	$0.208
Depreciation and repairs..	6,814.24	0.034
Supplies	4,468.20	0.023
Total	$52,813.36	$0.265

AIR MEASUREMENT BY FLOW THROUGH ORIfices was studied experimentally by A. O. Müller at the Municipal College of Mechanical Engineering at Leipzig. An abstract of his results is printed in the "Zeitschrift des Vereins Deutscher Ingenieure" of Feb. 22, 1908. Müller used only circular orifices, beveled off on the downstream side to leave an edge thickness of 0.004 in. Five diameters were used: 0.92-in., 1.42 ins., 1.73 ins., 2.06 ins., and 2.45 ins. The air was drawn from a closed receiver, and the volume discharged was determined by calculation from the initial and final pressures and temperatures in the receiver; the square of the mean of square-roots of pressures measured at equal intervals was taken as the equivalent pressure of a single run. These equivalent pressures ranged up to 2 and sometimes 2½ ins. of water. The orifices were tested in four different positions: (1) directly in the side of the receiver, discharging into the atmosphere; (2) in the side of the receiver, but discharging into a pipe of 3¼-in. clear diameter; (3) at the end of a 3¼-in. pipe 59 ins. long, discharging into atmosphere; and (4) interposed between a 59-in. and a 60-in. length of 3¼-in. pipe.

In case (1) the coefficient of discharge, i. e., the quotient of actual quantity of flow per second divided by area of orifice $\times \sqrt{2gh}$ was found to be measurably constant for the different sizes of orifice tested, the mean value being 0.597. In case (2) the coefficient of discharge was 0.632 for the 0.92-in. orifice, 0.685 for the 1.73-in. orifice, and 0.764 for the 2.45-in. orifice. In case (3) the coefficients of discharge for the same three sizes were 0.603, 0.644 and 0.755. In case (4) all five sizes of orifice were used, and their coefficients of discharge were. 0.641, 0.689, 0.750, 0.854 and 1.084. In every test, the coefficient proved independent of the pressure difference, the recorded variations being within the limits of error; the values given above for the coefficients are the averages for a series covering pressures from a head of water of a small fraction of an inch to a head of 2 or 2½ ins. Müller also computed from the results of cases (2) to (4) the coefficient of contraction, on the assumption that the loss of velocity beyond the vena contracta is a complete loss by impact. He found this coefficient to vary from 0.602 to 0.583 in case (2), while in cases (3) and (4) it varied in the inverse way, i. e., from a value of 0.602 to 0.000 for the smallest orifice to a value of 0.691 to 0.697 for the largest. He believes that orifices are more accurate for measuring the flow of gases than the Pitot tube.

*Compiled by F. W. Hanna, Engineer, U. S. Reclamation Service, Washington, D. C., from cost data submitted by W. W. Patch, Engineer, U. S. Reclamation Service, Belle Fourche, S. Dak.

NEW SANITARY DETENTION BARRACKS AT THE U. S. NAVAL TRAINING STATION, NEWPORT, R. I.

By R. E. BAKENHUS.*

The detention or receiving barracks recently erected at the U. S. Naval Training Station, Newport, R. I., possess a number of interesting features. These barracks were built for the purpose of housing the newly enlisted apprentice seamen in a state of practical quarantine during the first three weeks of their six months period of preliminary training on shore. Besides the novel and unusual purpose of these buildings, and the special sanitary and structural details embodied at moderate cost, they are of interest on account of the great speed in planning and construction. The appropriation was so small that it was necessary to exercise the most rigid economy in the designs consistent with durability and serviceability.

Any one of the newly enlisted men before arriving at the station may have been infected with the germs of some communicable disease, ready to develop within the period of incubation into scarlet fever, diphtheria, spinal meningitis or other disease, corresponding to the original germ. As it is of extreme importance that the main body of from 1,200 to 1,600 apprentices should not be subject at any time to infection by contact with such cases, the newcomers are housed in entirely independent buildings—the new sanitary detention barracks. No communication whatever between the two groups is allowed, the newcomers' camp being treated in every way as an infected one. The period of detention is 21 days, or long enough to cover the incubation period of any known disease. It is evidently important, also, that the arrivals of one day should not infect those of any previous day. Otherwise an avenue is opened for the carrying of disease into the main group, and there is also danger of a local epidemic. For this reason those in detention are quartered in groups according to date of arrival, with no communication between the living spaces, as described later.

Besides adopting the means described for preventing the spread of disease, another vital object from the sanitary standpoint is to *prevent the development* of disease by providing for each occupant the most healthful surroundings as to sunlight, fresh air, warmth, and cleanliness, and by devising and adopting structural features to facilitate cleaning and disinfecting, thus giving the well the best opportunity to remain well, and the infected the best opportunity to overcome the disease germ. It may be added that any case of serious illness, as soon as discovered, is transferred to the near-by naval hospital.

GENERAL ARRANGEMENT.

There are four two-story dormitory buildings (Fig. 1), each having four non-communicating sets of living quarters, two on each floor, or a total of 16 sets. Each of the living quarters for the 13 men has one large sleeping room or dormitory, one room of equal size for day use, one serving room or pantry and one toilet room. The accommodations, designed with a liberal allowance of air space for 13 occupants, have in the stress of service been found to answer for 18 to 20, without exceeding the safe sanitary bounds.

There is also an administration building (Fig. 2) containing offices, quarters for permanent force, laundry, galley, storerooms and boiler room, with heating apparatus for all buildings.

The buildings are so placed as to have each one face south. A system of air and pipe ducts extends from the boiler room of the administration building to the dormitory buildings.

SPECIAL SANITARY FEATURES.

Each set of quarters has a separate outside entrance, with absolutely no interior communications between quarters. The men can mingle in the open air, only, where the surgeons regard the transfer of germs as very unlikely.

The sleeping room has a total air space of 7,150 cu. ft., giving from 350 to 360 cu. ft. per occupant with 20 occupants, or 550 cu. ft. with 13 occupants. The living or day room which adjoins is of the same size. Large double doors connect these two rooms, and if kept open at night increase the space per person. A fan system is provided, as described under "Heating and Ventilating," for supplying 30 cu. ft. of fresh warmed air per minute per person, considering dormitories and living rooms simultaneously occupied.

The beneficial effect of a flood of sunlight is well recognized. Each dormitory has three large windows facing south and in addition three facing north. Each living room in the first story has two windows facing south and two facing west (or east), while the second story living room has three south windows and two west (or east). The toilet room has two windows facing east (or west) and one facing north. The toilet rooms are so arranged that bright sunlight falls even on the fixtures for at least a part of each day.

Toilet rooms each contain two water closet bowls made of heavy, finely glazed porcelain, with porcelain seats integral with the bowl; two urinals of glazed porcelain, with shallow cast-iron partitions, and one punctured pipe shower bath 12 ft. long. The floor is of concrete, pitched toward the floor drain. In front of the urinal the floor is raised 1 in. to insure standing close, and drainage of drip. The room is large and contains no partitions, which allows a free circulation of air, a better penetration of sunlight, gives less surface to clean and insures greater cleanliness. By placing shower baths and fixtures in one large room, rather than in two smaller rooms, much was gained.

Serving rooms have wooden shelving and a galvanized iron sink, with back. The space between the back of the sink and wall is filled with cement mortar. Shelving at all points is 3 ins. from the wall, except at braces, the object being to avoid all crevices for vermin or dust.

Inside wall surfaces are flat and all of brick. They have been painted, present a smooth appearance and are easily cleaned. The surface is much superior to plaster, as it is not subject to cracking, nor to indentations under the rough usage. A 2-in. air space in the exterior walls gives ample insulation from dampness and cold.

A concrete cove molding is used with concrete floors at the angle with wall. A ½-in. horizontal chase was left in the brickwork so that the cove is flush with both wall and floor. With wood floors a wooden cove is used, the slight space between the wall and molding being filled with coal tar or slater's cement.

The messing arrangements are believed to be unique from a sanitary standpoint. There is a common galley or kitchen, from which the food is carried by each mess attendant to his own serving room. The mess gear (i. e., dishes) is not removed from the set of quarters to which it belongs. By this means direct contamination between various groups, through the mess gear, is prevented. There is practically no danger of contamination from the common galley, which could be avoided by having a separate galley for each mess. The benefits of the simple administration of a central galley with the sanitary benefits of divided mess gear are thus combined. This detention group is believed to be the first instance in which this principle has been applied.

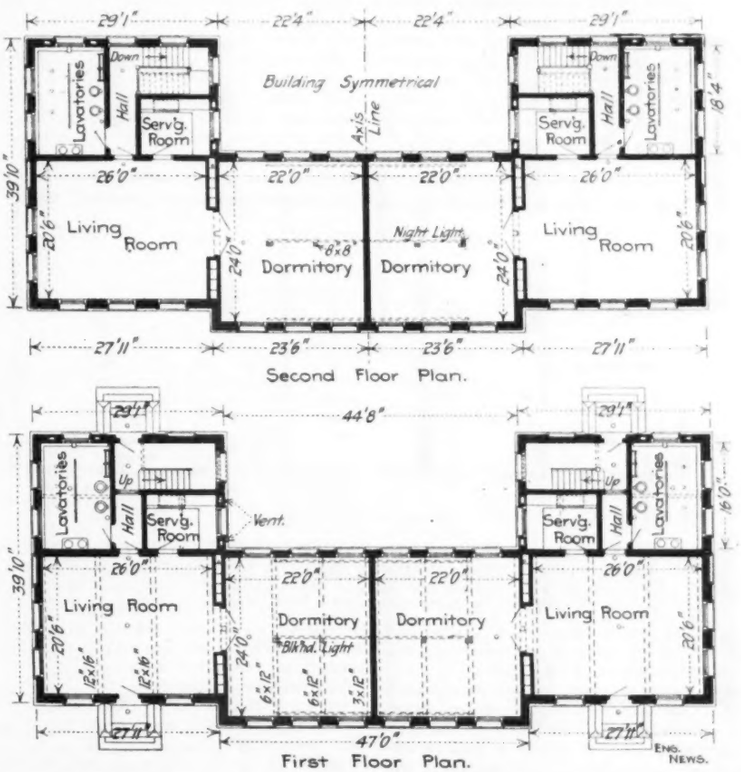

FIG. 1. FLOOR PLANS OF SANITARY DETENTION BARRACKS, U. S. NAVAL TRAINING STATION, NEWPORT, R. I.

HEATING AND VENTILATING.

All sleeping and living rooms are heated by the plenum or forced air system. Thirty cubic feet of warm air per person per minute are forced by a centrifugal fan into each room night and day. The fan, which is located in the boiler room, draws air through a stack with an opening above the roof and forces it over a set of heating coils, whence it passes through underground concrete conduits to the several buildings and up the vertical flues in the brick walls. It is discharged 2 or 3 ft. below the 14-ft. ceiling, in a horizontal direction. In cooling, it falls and spreads, insuring an even distribution. On the same side of the room with the inlet, and near the floor, is an outlet register and flue, through which the foul air is forced through the roof. If the fan, through policy or neglect, should be stopped, the rooms, in the winter at least, would quickly become cold and result in the starting of the fan, with a plentiful supply of fresh air. Where, on the other hand, the exhaust system with direct

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heating is installed, the fan may be stopped without noticeable discomfort, but with a vitiation of the air.

Toilet rooms, serving rooms and halls are heated directly by steam pipes, and these rooms have foul air outlet ducts to the roof. The tendency is of course for air to move from the living space at the higher fan pressure into the toilet rooms, and not vice versa.

The feed and drip lines to buildings are carried in the fresh air conduits. All heating surface is in the form of trombone coils with check valves on the return side. Each building has two steam traps discharging into a common return. The pressure carried is from 5 to 10 lbs., reduced from 80 lbs. by a valve in the boiler room.

The boiler room (Fig. 2) contains one 100-HP. fire tube boiler, with the flue gases making a third pass over the top of the shell; also one 40-HP. locomotive boiler, one centrifugal blower, one London type air heater, one engine and one motor for driving fan and laundry, one return tank or hot well, two boiler feed pumps and one feed-water heater. The feed-water heater is used principally to supply hot water for washing and bathing. Hot water pipes to all buildings have returns, with a small circulating pump, by

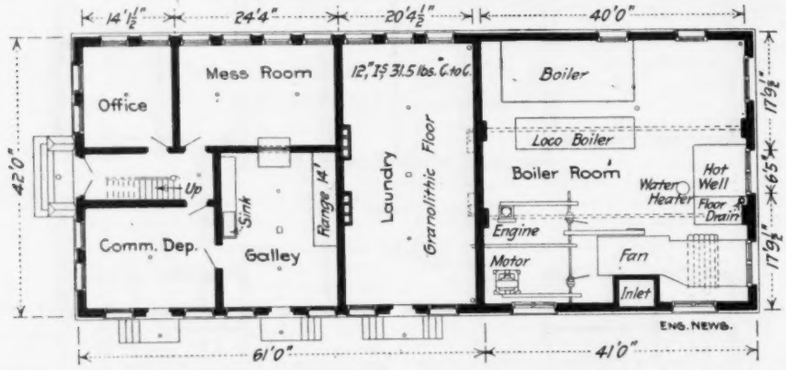

FIG. 2. FIRST FLOOR PLAN OF ADMINISTRATION BUILDING, SANITARY DETENTION BARRACKS, U. S. NAVAL TRAINING STATION, NEWPORT, R. I.

(The second floor plan shows a flat roof and skylights over the boiler room; a dormitory over the laundry; two bedrooms, a living room, shower baths, etc., at the front.)

means of which waste of water and time are prevented, as the faucets give hot water at once.

STRUCTURAL FEATURES.

Foundation walls are of 1:3:6 concrete and, except at a few points, rest directly on ledge, which is at the surface over most of the site. Special care was used to obtain a smooth exterior surface. Immediately after removing the forms a brush coat of cement was applied, the result being satisfactory. The water table was similarly built with very careful forming.

Outside walls are of common brick, 14 ins. thick, with a 2-in. air space for dryness and warmth. Headers averaging 1½ per sq. ft. extend across the air space to tie the outer 8-in. and inner 4-in. walls together. Interior walls are all of brick, either 8 or 12 ins. thick. The wall between the sleeping and day rooms contains the fresh air ducts and outlet flues. Mortar for brickwork is composed of 2 parts Portland cement, 1 part slaked lime and 6 parts sand.

Window sills and cornices are of cast stone, composed of 1:2½:5 concrete, with a ½-in. surface coat of 1:3 cement mortar. A plaster model was first made and from this varnished collapsible molds or forms, also of plaster. The stone was cast face down. The face layer was mixed comparatively dry and deposited first; then 3-in. layers of the concrete; each layer was thoroughly tamped, and then slightly roughened for bonding. Where a facing extended up the side of the mold, the fine material, mixed rather dry, was carried up in wedge-shaped masses, equal in height to the concrete layer about to be deposited. The molds were overturned 24 hours after filling and the stone allowed to rest evenly on a bed of moist sand. While setting, the stone was periodically watered. The results were good, as no crazing or cracking of any kind has appeared. The cost was considerably less than cut stone and the appearance and general character almost as good. The 1 to 3 mixture for facing, rather than 1 to 2, was adopted because of its superior texture and much less likelihood to surface cracks; examination of existing structures bears this out.

The floors of living rooms and dormitories are of mill construction, using 2½-in. spruce plank, tongued and grooved, and a wearing surface of "B" grade, edge grain yellow pine. Floors of serving rooms, toilets and halls are of concrete. Roofs are flat, tar and gravel, on 2-in. spruce. Door and window frames are of wood, set tightly in the brickwork.

FIREPROOFING.

All walls, including interior as well as exterior, are of brick. The only vertical combustible material is in the doors, windows and two 8 × 8-in. hammock hanger posts in the sleeping rooms. The stairways are of wood, enclosed in brick walls. The floors of the sleeping and living rooms, as stated, are of mill construction, with very heavy beams and 2½-in. floor plank. The remaining floors are entirely of concrete. The ceiling height is 14 ft. A few tables, chairs and shelves form the only additional combustible material. The center wall extends the full height of the parapet, and has no openings whatever. There are no fires in any of the buildings, except in the boiler room and galley, both of which have concrete floors.

PLANNING AND CONSTRUCTION.

The appropriation was made by Congress as an emergency measure at the latest moment. Completion of the buildings was most urgently desired by the Bureau of Navigation within the brief space of five months after instructions to proceed were given. It was not possible to set aside any of the governmental regulations as to advertising, etc., nor was it possible to award a contract on a cost-plus-profit basis before plans were complete. It was evident that special efforts were necessary, as in the routine course of departmental business from two to three months are required to print specifications, advertise and award contract *after* plans and specifications are complete. Complete drawings of floor plans, elevations, concrete ducts, survey and general layout, together with all specifications, were completed in 30 days, or by Aug. 11, 1906. These were sent to the Bureaus of Navigation and Medicine and Surgery in Washington for approval (having been previously submitted in a preliminary state), and were returned approved by Aug. 17. In the meantime the work had been advertised so that applications from bidders were in hand. To save the long delay incidental to government printing, typewritten copies of the specifications were issued. Bids were opened on Aug. 30. The contract was awarded to the J. W. Bishop Co., of Worcester, Mass., on Sept. 6, or in less than two months after the first instructions to proceed with the plans were received.

Excellent progress in construction work was made, in the face of unprecedented scarcity of labor. Four of the five buildings were practically complete within the allotted time. The fifth was delayed by an early spell of cold weather, but was completed by Dec. 31. The entire project was thus completed in nine months and 20 days after instructions to proceed with the plans were given.

COST.

The entire cost of the buildings and the principal equipment was $92,426. The cost per cubic foot of building (from ground level to parapet) was 14.75 cts.; the cost per square foot was $4.95. The cost per occupant, allowing 550 cu. ft. of sleeping space per person, was $410. Based on 400 cu. ft. of air space in sleeping rooms per person, the total cost per occupant was $297. The unit costs are based on the total cost of buildings, power plant, ducts and equipment.

EXPLORATIONS FOR HUDSON RIVER CROSSING OF THE CATSKILL AQUEDUCT, NEW YORK CITY.

By ALFRED D. FLINN,* M. Am. Soc. C. E.

The Hudson River is the greatest natural barrier obstructing the line of the 500,000,000-gal. Catskill Aqueduct now under construction by the Board of Water Supply for conveying an additional supply of water from Catskill Mountain drainage areas to New York City. So far as known, before the board began its extensive explorations, no bedrock cross-section of the river had ever been determined by drilling, south of Albany. Only surmises regarding the depth to rock at certain points and some wash-drill information existed. After more than two years of persistent work, the board has not succeeded in making a complete rock cross-section. However, several suggested lines for the aqueduct crossing have been sufficiently explored to permit the final location to be determined. On this line much information of a negative sort has been gathered, and some of a positive character. Thorough geological studies in field and office have been made by the following expert geologists: Prof. James F. Kemp and Dr. Charles P. Berkey, of Columbia University, and Prof. W. O. Crosby, of the Massachusetts Institute of Technology. More is known of the geology of the Hudson, at least of the 22 miles between Anthony's Nose and Pegg's Point (see Fig. 1), than ever before.

Besides the river itself the location for the approach on each side for a large aqueduct is a serious element in the problem, for the topography is not especially favorable for aqueduct construction at the necessary elevation. Hundreds of miles of line have been surveyed or reconnoitered. For numerous reasons, the line crossing the river from Storm King Mountain on the west bank to Breakneck Mountain on the east has been selected. This is a picturesque spot known as the northern gate to the Highlands of the Hudson. A tentative location having been made at this place more than a year ago, drilling and other explorations have been concentrated in this vicinity since.

The geology of the region under exploration is of such fundamental importance that the deductions and opinions of the expert geologists are particularly interesting. From several valuable reports the immediately following paragraphs are selected to set forth the character of the problem and some of the reasons for the decision made. Prof. Crosby states:

> The Hudson is a true fiord, through which the tide ebbs and flows; and in conformity with this view, it is found that the bedrock channel or gorge of the river is not only of a breadth proportional to the stream that made it, but that it has a depth fully justifying its designation as a gorge. This great depth, although, doubtless, tending to increase seaward, must be continuous to the headwaters of the river. The real problem, therefore, is not so much to find a crossing with a minimum depth of bedrock, as one which would combine with a sub-fluvial tunnel of minimum or moderate length, geologic conditions insuring safety during and after construction and permitting a maximum elevation of the tunnel in the bedrock. The crossing must afford also a favorable location of the aqueduct

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with reference to tributary gorges and the general topography, and with reference to the relative lengths of the different types of aqueduct (cut-and-cover, grade tunnel and pressure tunnel) the total length of aqueduct and the total cost.

The coast survey chart shows that the depth of the river, or of its main channel, is variable, and also that its bed is not graded, the depth varying inversely as the breadth, and in a way to give rise to many pools or basins. The deepest point in the section of the river under consideration is also the narrowest. This is on the south side of Constitution Island [Fig. 1], where the soundings show 216 ft. of water, while the shallowest part is that immediately north of the Highlands, where it is exceptionally broad. But while this is characteristic of a silted-up fiord, the case is entirely different for the bedrock floor of the gorge. It may not be assumed that the grade of this is necessarily uniform throughout, but it cannot be doubted that, with very slight exceptions, the elevation must diminish seaward, save as the grade has been modified by glacial erosion.

The chief advantage of a crossing in the Highlands over one farther north is the avoidance of the Casper, Wappinger and Fishkill Creek crossings. It is not probable that more favorable conditions, as regards the depth of the bedrock surface, exist at any point between Storm King and Anthony's Nose than at Storm King. The probable depth of the bedrock on the proposed crossing at Storm King, while exceeding 500 ft., is much less than 1,000 ft. The depth would not be materially less on the Peggs Point-Clinton Point profile.

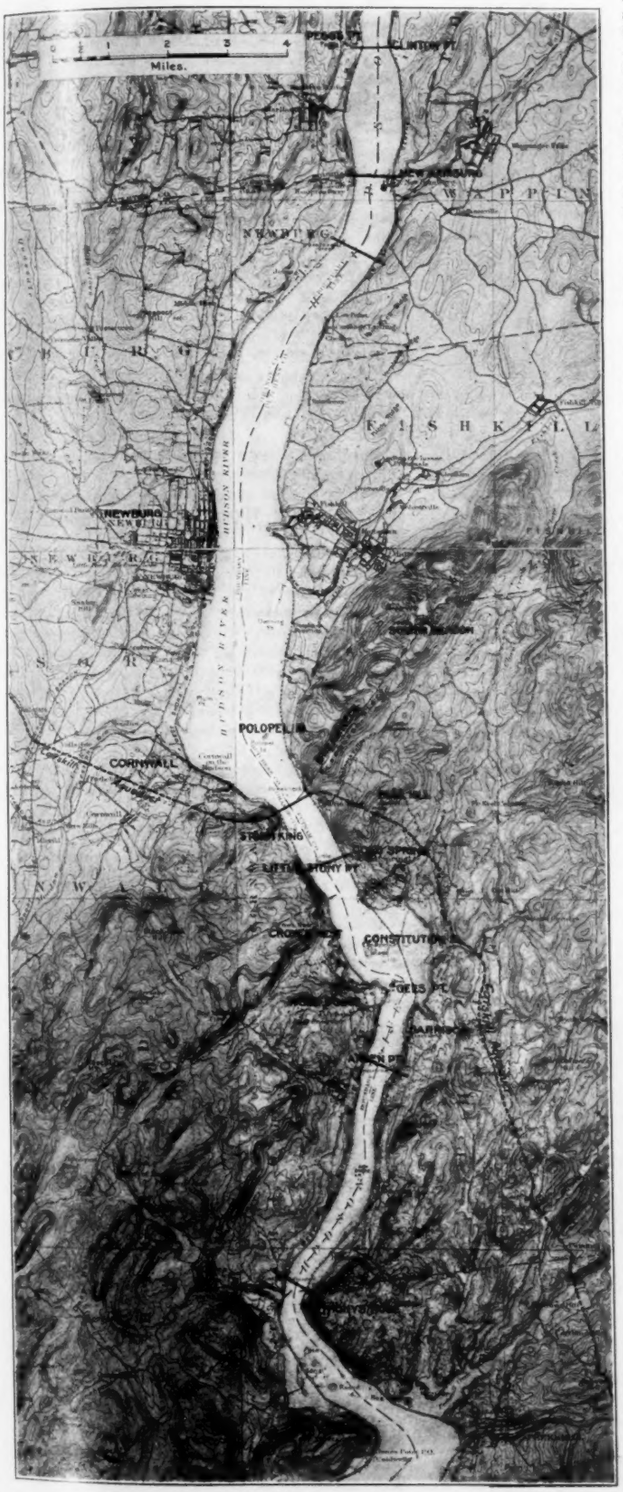


FIG. 1. KEY MAP TO EXPLORATIONS FOR THE HUDSON RIVER CROSSING OF THE CATSKILL AQUEDUCT, NEW YORK WATER SUPPLY.

Prof. Kemp has summarized conditions and submits conclusions as follows:

Three crossings have been examined in the Highlands, respectively, from north to south: (1) The Storm King; (2) The Little Stony Point; (3) The Arden Point.

The mountainous ridge of the Highlands strikes across the Hudson valley and cuts off the relatively unmetamorphosed sedimentary rocks with a great series of fault escarpments, formed by the granite and gneisses of older date. The latter are highly crystalline and all possess a banding or gneissoid foliation, which has been produced by pressure, and rock flowage under heavy load. Storm King and Crow's Nest mountains, on the west bank, and Breakneck Ridge, Bull Hill, and South Beacon, on the east bank, consist of granite, intrusive in the gneisses just described. The granite itself is somewhat banded and is further penetrated by some dark trappean dikes.

To the question of a great fault in this part of the river very careful attention has been given. If one were strongly developed, one ought to find in its line north and south of the narrow pass of the river greatly crushed and broken rock. Polopel Island is of this character and so are the cuts of the N. Y. Central Railroad on the mainland just adjacent, but they lie right in the line of the great northeast and southwest overthrust fault, which has given the northern escarpment of the Highlands. Little Stony Point is quite solid granite. Constitution Island, Gees Point, and the shore north of Garrison are also quite solid along this line and do not support the hypothesis of a huge fault. However, from Garrison following the river south, much crushing and shattering along another northeast and southwest zone is found.

Prof. Kemp, therefore, felt unable to establish a great line of displacement between Storm King and Breakneck Ridge, but from the evidence in hand was inclined rather to emphasize the sheeting and jointing which the rocks exhibit along the river banks. He further calls attention to the fact that

in the faces of Storm King, Breakneck and Crow's Nest mountains lines of disturbance resulting in some shearing and very pronounced jointing are plainly discernible and run across the river in a general direction, N. 50° E., magnetic. They serve to divide the faces of the mountains, and more especially Storm King and Breakneck, into buttresses. The Storm King tunnel line crosses almost parallel with them and, if it could be located as nearly as possible between two, it would be in general most favorably situated. Still the crossing of a jointed zone on the diagonal, especially beneath the shallow water of the east bank, would probably give slight trouble. On the whole, the Storm King crossing is believed to have the most solid rock.

Dr. Berkey, from independent studies, brings out some different phases of the problem, but reaches the same general conclusions:

In making a comparison of the various proposed Hudson River crossings it becomes at once evident that they fall into two distinct groups. One group, that may be designated the New Hamburg group, is represented by the "Peggs Point," "New Hamburg" and "Danskammer" lines, and is characterized by a series of much folded, faulted and crushed sedimentary rocks, chiefly slates, limestones and quartzites. The other, that may be called the Highlands group, is represented by the "Storm King," "Little Stony Point," and the "Arden Point" lines and is characterized by crystalline metamorphic and igneous rocks of a much older series.

This region, including as it does the Highlands of the Hudson and the district lying along its northern border, is probably the most complicated, stratigraphically and structurally, to be found within the borders of the State of New York. The strata represented include more than half the total geologic scale, reaching from the oldest sediments following the Archean up to and including a large part of the Devonian series. The rock types include granites, diorites, gneisses, schists, marbles, serpentines, slates, quartzites, sandstones, limestones, shales, and, less extensively other varieties. The region bears the evidence of no less than three periods of mountain-making disturbances, each in its turn adding to the succession of foldings, faultings, and unconformities that characterize it.

The New Hamburg group of crossings is in the later sedimentary series. The Hudson river slates and Wappinger limestone are the chief formations. There are several fault lines belonging to the major NE. and SW. series to be crossed by such a tunnel—one of them in each case being met at considerable depth and beneath or adjacent to the river. These faults, besides being the weakest zones of rock, as a rule, are in addition the most unstable in any possible future earth movements. Although there is no evidence, so far as known, of recent displacements along these lines, still such a thing is always possible, and recent serious effects of this kind on the Pacific Coast suggest caution. It is manifestly advisable from every standpoint to avoid a tunnel if possible that crosses several of them.

Among the Highlands group of crossings there is considerable difference of structure dependent upon the exact location of this crossing. The Storm King crossing is wholly in massive granite. The rock is the most massive and substantial body of uniform type to be found in the Highlands. The course of the river of necessity indicates some possible weakness in that direction. This weakness may be some minor crushed zone or even the jointing alone that prevails throughout the exposed cliffs. But there is no direct evidence of faulting cutting the tunnel line, and such crushing as may be encountered is believed to have originated at such depth and under such conditions as to cause no large disturbance. The freedom of this formation from all bedding structures, and consequently from all natural courses of underground water circulation on a large scale, is an additional factor. There is absolutely no place, within the region available, where the Hudson River can be crossed from grade to grade in good ground of a single type with so great probability of avoiding all large lines of displacement.

There are probably many sources of additional weakness and complications of structure now wholly obscured beneath the covering of drift or lying beneath the river itself; but, however many there may be, it is not believed that they can materially change the general situation. The major characteristics are so well marked that any addition to the number already known would in all probability increase the difficulties of the less favorable routes at least as much as, and perhaps more than, those now considered superior. The difference in the estimated cost is favorable to a crossing in the Highlands by so great an amount as to fix the crossing of the Hudson River in this region.

The geologists were consulted very early in the explorations, and their advice had in locating the drill holes and test shafts. Their studies have closely followed the progress of the work. They have, besides, tramped exten-

sively over the region, closely examining outcrops, topography, railroad cuts and other surface indications. Naturally, opinions have been modified as data have been accumulated.

Wash borings were begun in September, 1905, and finished in August, 1906. There were 226 holes put down on 14 cross-sections of the river

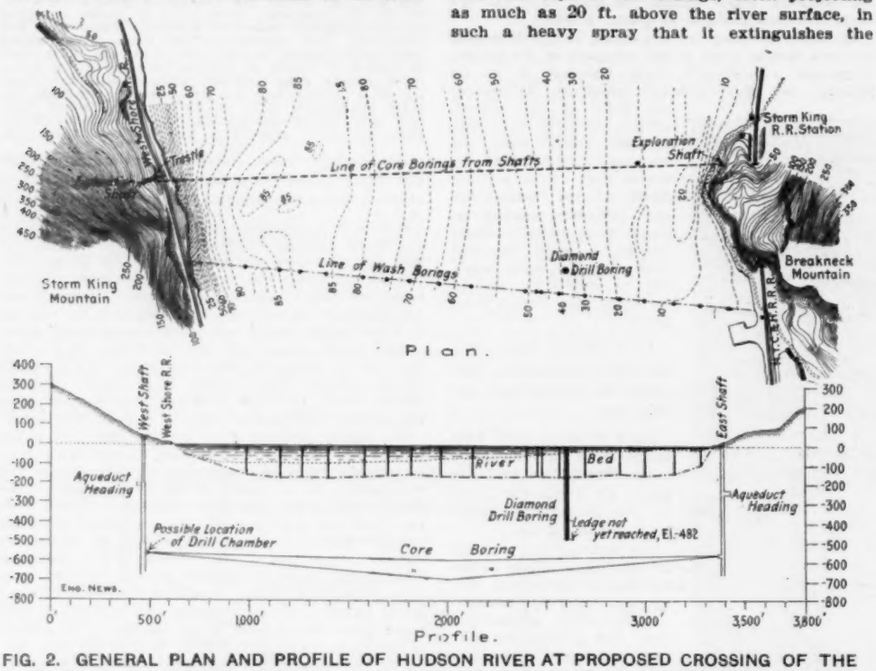


FIG. 2. GENERAL PLAN AND PROFILE OF HUDSON RIVER AT PROPOSED CROSSING OF THE CATSKILL AQUEDUCT, SHOWING WASH BORINGS, EXPLORATION SHAFTS AND PROPOSED HORIZONTAL CORE BORINGS.

(The diamond drill boring shown is hole No. 10. See Figs. 3 and 5.)

from Pegg's Point to West Point. This work was done generally from the deck of a steam lighter and could not be carried on during the winter months because of the drifting ice. Mr. F. W. Miller, of New York, was the contractor. On account of the great depth of the buried gorge and the thickness of the material overlying the ledge, it was found to be impracticable to ascertain the position of the rock with these borings. Core borings were, therefore, begun in April, 1906, and were carried on until December, when the drifting ice caused a cessation of the work for the season. The location of the two kinds of borings at the proposed Storm King crossing are shown in Figs. 2 and 3. Core borings were made under Contract No. 1 with the American Diamond Rock Drill Co., of New York. The work was found to be very difficult, and the results accomplished fell far short of the progress anticipated. In addition to the holes in the channel of the river, two borings were made, wholly in rock, on the shore at Storm King Mt., one vertical and one inclined, and one inclined hole on the east bank. These two latter holes were started in the outcropping granite and inclined about 30° from the vertical, so as to pass under the river bottom as they went down. The hole on the east shore was driven to a depth of 275 ft. and the one on the west to a depth of 566 ft. Both holes were in granite for the full depth. The positions of these holes are shown on an accompanying profile, Fig. 3.

Men familiar with subaqueous drilling have characterized this undertaking as one of the most difficult of its kind. At the selected location the river is narrow and the mountains rise precipitously to an elevation of more than 1,200 ft. above the water. The tidal range is about 3 ft., and the current reaches a velocity of approximately 3½ mi. per hr. Through the gap the wind frequently draws with such violence as to interfere with the work. In the winter, the river is covered with ice or filled with ice floes, but the ice rarely becomes strong enough to support the heavy drill rigs. In the open season, especially during the summer, there is a heavy traffic on the river, including many large passenger steamers and tugs with long tows of barges. The wash of the boats has caused much annoyance to the drillers. On account of this traffic the U. S. War Department would not permit obstructions in the navigable channel to be placed closer than 800 ft. apart. Night work has not proved feasible, for the wash water is blown from the tops of the casings, often projecting as much as 20 ft. above the river surface, in such a heavy spray that it extinguishes the torches. Rain makes very little disturbance to the work because the spray affords conditions most of the time which are much like rainy weather. At the great depths to which the holes go the water is so cold, its temperature being about 47° F., that difficulty is experienced in exploding the dynamite necessary for breaking boulders. Occasionally, to overcome this trouble, the dynamite was thermally insulated by being wrapped in oiled paper and enclosed in a bottle; but, with casing smaller than 4 ins. in diameter, it is hard to keep the dimensions of the package small enough. This expedient was resorted to, however, only where there was probability of great delay in pulling back the casing before a shot. At depths of 300 ft. and greater the sand often rushes up into the casings as if under pressure, and rises as much as 30 ft. in the casings. Sometimes, when the casing has been cleaned out at close of day, the sand will have risen to the same height by morning. If by any mischance the casing is broken at these depths, the sand is likely to force its way through the break. Boulders are usually blown out of the way, instead of being drilled and blasted, but these intrusions of sand fill the drill holes and interfere also with the placing of the dynamite for blowing. In some cases the powder has been forced into place by strong pumping down the casing. There is little clay or other binding material in this ground, and consequently it caves constantly ahead of the casing.

High winds have been responsible for the loss of a number of holes, by driving the lighters against the casings so as to bend or break the latter beyond recovery. If the wind blows the lighter away from the casing little or no harm is done, for then it is simply a matter of casting loose. Even six to nine anchors weighing 600 to 1,000 lbs. each have proven insufficient to hold the lighters against some of the winds. The force of the wind has been great enough to break ½-in. chain. Waves have run so high as to swamp vessels (they were small ones, to be sure) in Cold Spring and Cornwall harbors.

Driving the casings has not been easy, owing to the frictional resistance of the materials constituting the river bed and to the obstructions caused by boulders. Usually a gain of only about 100 ft. of depth has been possible with each size of casing before it became necessary to drive so hard as to break the casing or batter its upper end so that additional lengths could not be coupled on. Hence in order to go to depths of several hundred feet, the contractor has been obliged to start with very large casing and reduce several times. Each size of casing extends from the top of the hole; that is, from the surface of the water or above, to the limit of depth reached. When winter caused a cessation of work, the casings of the unfinished holes which it was desired to resume in the spring have been uncoupled at a safe level below the surface of the river and left with the hope that they could be recovered when work was resumed. This scheme has met with success; a simple process of recovering such holes has been used. After location is given by the engineers, a piece of pipe suspended horizontally from two ropes is dragged until it encounters the casing. A small pipe is then inserted in the top of the latter as a guide and the connection made by a little careful trying to get the threads started rightly.

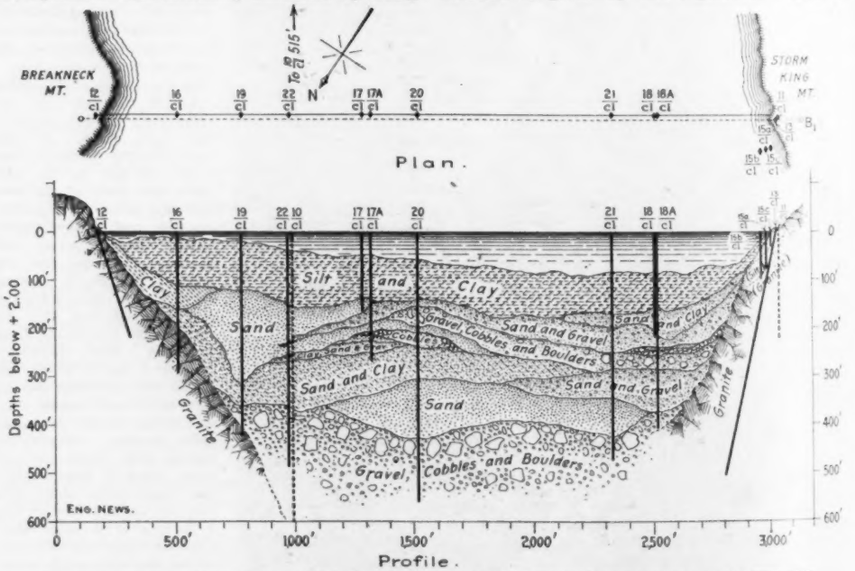


FIG. 3. PLAN AND PROFILE OF BORINGS AT STORM KING CROSSING, REVISED TO DECEMBER 17, 1907.

(This profile shows the results of the core borings. Hole No. 10 is shown in plan in Fig. 2 and in detailed section in Fig. 5.)

Natural difficulties have not been the only ones to be contended with, as the history of hole No. 10 shows. This boring was started on Sept. 6, 1906, and abandoned during the following winter. Some time was spent in recovering it the next spring, and the 4-in. casing was found broken and offset, so that at first it was deemed impossible to continue the drilling. After patient endeavor drilling was resumed in April, 1907, and by Aug. 29, 1907, 140 ft. of depth had been gained. At this date a steamer, which had become disabled some distance up-stream, was carried by the current down against the casing and bent and broke it beyond repair. Only a short time before the casing had reached rock at a depth of 608 ft. and the diamond drill had penetrated 9 ft. into the rock. After many months of costly labor, this is the only hole to reach rock in the deeper gorge of the river, if, indeed, bedrock was really reached here, and not some much thicker boulder than had been previously encountered.

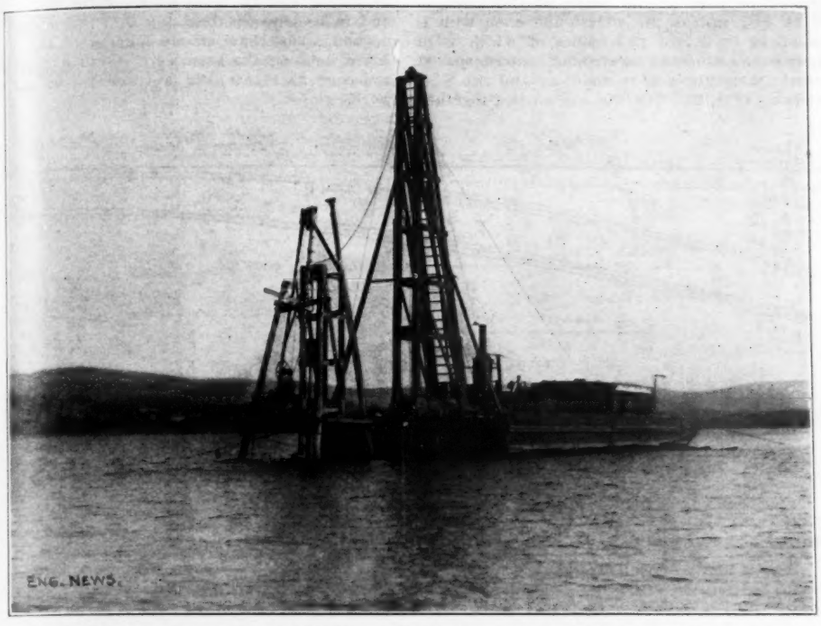


FIG. 4. VIEW OF DRILLING MACHINE, SUPPORTING TOWER AND LIGHTER ON STONY POINT LINE, HUDSON RIVER, SEPTEMBER 15, 1906.

The earlier holes, when the surmise as to the depth to bedrock was much more modest, were started with 6-in. casing, but the most recent deep holes have been started with 15-in. casing. When rock is reached, a 2½-in. casing is put down and seated on the rock and a diamond drill used, which makes a 1 3-16-in. core. After the casing is seated on the rock and the diamond drill started in real rock, the natural difficulties are pretty well overcome. The only positive information as to the position of the rock in the deeper part of the river has been obtained in holes Nos. 10 and 16; all other holes have yielded only negative information.

For a number of reasons it has not been feasible to support the drill rigs on the lighters. Four-pile towers (Fig. 4) were tried, but the piles had to be so long, the longest being 120 ft., that the erection of such towers became very difficult and costly. When completed they did not prove wholly satisfactory. Of course such long piles had to be spliced. Now a platform is attached to the casing itself, which is thus made to support the drill. For this purpose the casing is steadied by four guys with an anchor weighing 600 to 800 lbs. on each.

A profile of the river on the selected line, showing the borings made here up to the end of last season, is given as Fig. 3, already mentioned. The maximum depth of water is about 90 ft. There are about 10 to 12 ft. of silt or other soft mud, under which there is a bed of brick clay, and then sand and gravel, the gravel increasing in coarseness with the depth. Fig. 5 shows a progress chart for one of the holes. This is the form in which the information is finally filed in the headquarters office in New York City, as well as in the field office. Although the work was begun by the American Diamond Rock Drill Co., it was carried on last season by the Phoenix Construction Co. Mr. F. W. Belknap is the engineer for the latter company, and Mr. George H. Hammond has been the resident superintendent. Mr. Hammond was drilling expert for the U. S. Reclamation Service for several years.

It is highly important that this aqueduct crossing should be safe beyond peradventure, because, in the event of a break, repairs would require much time, even if practicable at all, and a substitute conduit or pipe of any kind could not be speedily put into commission, as might be done in some of the wider valleys with smaller streams. Hence still another method of exploration was decided upon, in order to get the fullest and most reliable information before completing the designs and proceeding to construction. In February, 1907, an agreement was made with the Cranford Co., of New York, to sink a test shaft on each shore of the river, and from these shafts to drill nearly horizontal diamond drill holes beneath the river at depths which would be likely to keep the holes in rock. (See Fig. 2.) Each hole was intended to be a little longer than half the distance between shafts, so as to be sure that the whole width of the river bed would be penetrated. If a hole should run out of rock, another hole would be started at a lower level.

These shafts were so located and designed that they can become permanent parts of the tunnel, unless unexpectedly unfavorable conditions should be found on this exact line. According to the terms of the agreement, these shafts were to have been sunk to Elev. — 650 by the middle of December, but when work was suspended on Dec. 7, 1907, only about 45% of this depth had been made, and consequently no drill holes had been started.

In a recent progress report Division Engineer William E. Swift gives a detailed description of the work at the test shafts, as follows:

> The east shaft, after 22 ft. had been excavated as open cut, is circular in section, in hard gneiss, the excavation being 16 ft. 10 ins. in diameter for 187 ft. At this elevation a tunnel heading was turned, on the land side of the shaft and the remaining 71 ft. of shaft is 15 ft. 8 ins. in diameter. The total depth sunk from the original surface is 280 ft.
>
> The west shaft, for the first 10 ft. is in earth and boulders and the next 210 ft. in rectangular, 11 ft. 4 ins. x 18 ft., excavated in rock similar to that at the east shaft. At this level a tunnel heading, similar to that on the east side, has been turned and the remaining 45 ft. are circular in section, 15 ft. 8 ins. in diameter. The total depth is 265 ft.

The east shaft was begun April 6, 1907, and the west shaft about May 1. Both shafts are timbered from the ground surface to the top of tunnel heading with 10 x 10-in. timber sets, about 6 ft. c. to c. No inside cage-guide timbers are in place. No excavating was done while timbering.

On the east side, two Sullivan compressors are installed, each with a capacity of 1,140 cu. ft. of air per min., delivering air under a pressure of 100 lbs. per sq. in. Steam is supplied by two 125-HP. Coatesville boilers; feed-water is obtained from the Hudson River. At the west shaft a similar plant is installed, except that only one compressor is in use. Water is obtained from the town supply. The shafts are lighted by electricity, generated in the power plants. The hoisting apparatus consists of boom derricks, with ⅝-in. wire cables carrying circular buckets, 3 ft. in diameter and 3 ft. deep, operated by National Hoisting Engine Co.'s hoisters, run by steam. Air is supplied to the drills through 3-in. wrought-iron pipe. Drills used on the east side are 3⅝-in., and on the west side 3¼-in., all Sullivan make. There are three sizes of Cameron pumps on the job, namely, No. 5, No. 9 and No. 12, but only No. 5 and No. 9 have been used as yet.

In the east shaft only about 5 gals. of water per min. have been encountered, except after heavy rains. This has been handled by bailing except for short periods, after a shut-down, when it has been necessary to lower the pump. In the west shaft the average quantity of water in the shaft has been about 12 gals. per min. This was handled by means of pumps until a depth of about 200 ft. was reached. The timbers were then sheathed from the surface to a point about 130 ft. below ground. At this level a plank collar was built between the timbers and the wall of the shaft, and lined with cement and clay, which was plastered to the rock. This collar conducted the water to a barrel-sump, from which a small piston pump raised it to the surface. Blasting has loosened this collar so as to make it less effective than when first built, but, with a few exceptions, the water passing the collar has been handled by bailing. Little additional water has been encountered in either shaft below the 130-ft. level.

These investigations have been carried on by the Board of Water Supply under the general supervision of Chief Engineer J. Waldo Smith. From time to time the problem has received the serious attention, also, of Consulting Engineers John R. Freeman, William H. Burr and Frederic P. Stearns. Division Engineer William E. Swift has been in immediate charge of the field work, under the personal direction of Department Engineer Robert Ridgway, of the Northern Aqueduct Department. Designing Engineer Thomas H. Wiggin prepared the drawings and specifications for the shafts and the horizontal drilling.

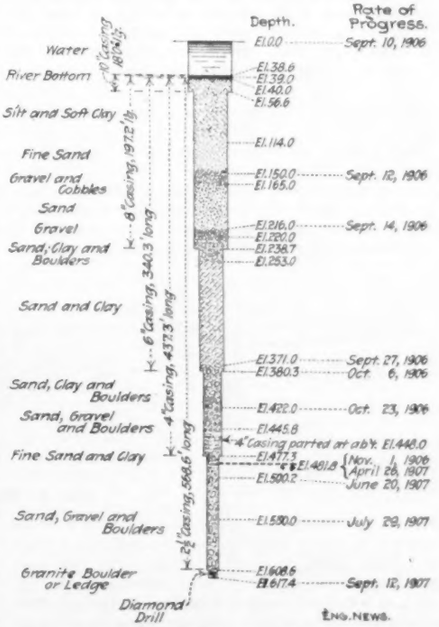


Fig. 5. Progress Chart for Drill Hole, Hudson River Explorations for Catskill Aqueduct.

Hole started Sept. 10, 1906; suspended, Dec. 16, 1906; resumed, April 26, 1906; abandoned, Sept. 12, 1907. Elapsed time, 368 days; working time, 182 days; number of shifts, 182.

Depth of water, 39 ft. Depth to rock, 608.6 ft. Rock penetrated, 8.8 ft. Depth of hole, 617.4 ft.

Contract price, 617.4 ft. at $11.25; 217.4 ft. at $13; average, $15.83 per ft. Cost of inspection, 51 cts. per ft. Cost to city, $16.34 per ft.

A SKEW THREE-HINGED REINFORCED-CONCRETE ARCH AT DENVER, COLORADO.

Cherry Creek, in Denver, Colo., is a stream about 80 ft. wide running oblique to the lines of streets between two buttressed retaining walls of reinforced concrete (Fig. 9). It became desirable, a few months ago, to cross this creek on the line of Bannock St. with a highway bridge having a roadway as near as possible in grade to the top of the side walls, replacing a two-span through truss steel bridge. Artistic considerations, drel columns also located definitely the load distribution and made more determinate the arch rib stresses.

The bridge as built is in one arch consisting of eight parabolic parallel three-hinged arch ribs varying in span from 132 ft. 5 7-16 ins. at the narrow part of the curve of the river to 137 ft. 11¼ ins. at the widest and each with a rise of 13 ft. 2 ins., two inches of which were allowed for settlement on striking centers, spaced so as to permit of a 36-ft. roadway and two 8-ft. sidewalks (Fig. 2). The ribs are all tied together rib reinforcement were not obtainable in greater lengths than 30 ft., where 70-ft. lengths were desired, the shorter lengths were butt-welded electrically, a transformer for the purpose being set up on the ground and connected with the city circuit. The joints so made were found to be strong enough to break the body of the bar and to be cheaper than any other form of connection, even than simple lapping of the bars. After welding, the bars were cut to length with a power hack-saw and at once placed in the work.

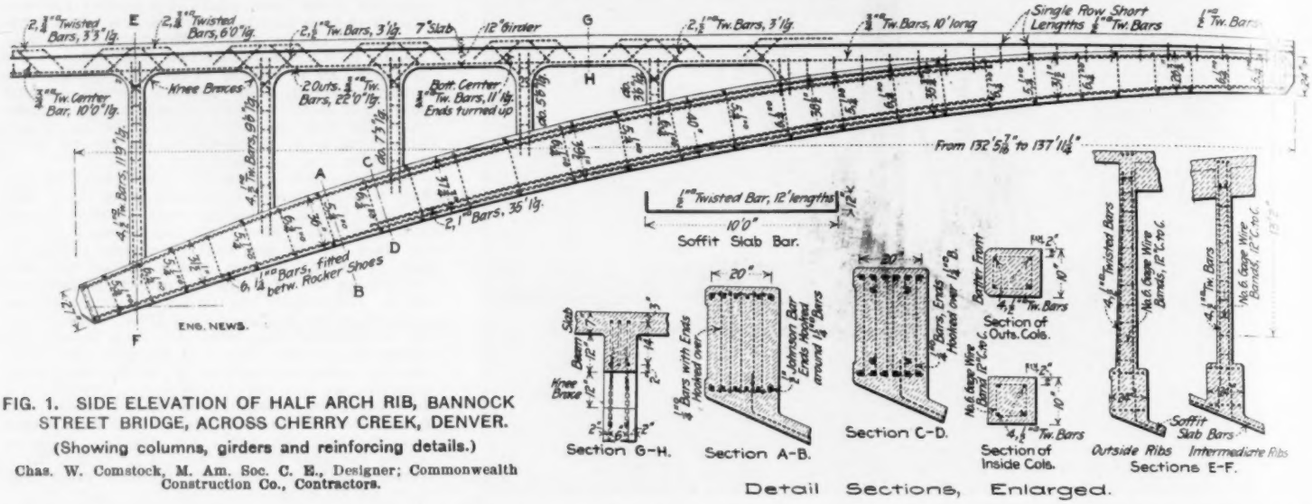


FIG. 1. SIDE ELEVATION OF HALF ARCH RIB, BANNOCK STREET BRIDGE, ACROSS CHERRY CREEK, DENVER.

(Showing columns, girders and reinforcing details.)

Chas. W. Comstock, M. Am. Soc. C. E., Designer; Commonwealth Construction Co., Contractors.

together with the advisability of conforming to the already erected retaining wall, seem to make a reinforced-concrete structure necessary, but the conditions at this point were peculiarly complicated. The center line of the street is at angle of about 36° with the axis of the river, which is on a curve of such a degree that there is a difference of nearly 6 ft. in length of crossings parallel to the street in a distance of 45 ft. Mr. Charles W. Comstock, M. Am. Soc. C. E., who was called in by the city to superintend the design and erection, had little confidence in the ordinary theory of skew arches and did not care to risk a design for a bridge of such an extreme skew based on this theory, and the time available for the work did not permit of the requisite study for the development of a rational theory. This left only a ribbed arch possible. The engineer, in addition, felt that the stresses, due to changes in temperature, required, in so large a span, an arch ring so heavy that any attempt to lighten the spandrel walls by openings would destroy the proportions of the structure. But open spandrels were considered necessary from an esthetic point of view. The creek, while subject to excessive floods, is for the greater portion of the year a mere bed of sand with a small stream of water winding over its surface. A very flat arch springing from the sand line and with solid spandrels would present more the appearance of a culvert than of a bridge. Moreover, open spandrels increase the passage area in time of floods, thereby adding to the stability of the bridge. Thus by a process of elimination the field was reduced to a reinforced-concrete three-hinged arch of a number of ribs. In this the presence of hinges precluded all temperature stresses so that a shallow arch rib could be used and consequently open spandrels. The spandrel columns also located definitely the load distribution and made more determinate the arch rib stresses.

The bridge as built is in one arch consisting of eight parabolic parallel three-hinged arch ribs varying in span from 132 ft. 5 7-16 ins. at the narrow part of the curve of the river to 137 ft. 11¼ ins. at the widest and each with a rise of 13 ft. 2 ins., two inches of which were allowed for settlement on striking centers, spaced so as to permit of a 36-ft. roadway and two 8-ft. sidewalks (Fig. 2). The ribs are all tied together on their lower flanges by a reinforced slab from the haunches to within about 11 ft. of the crown. From each rib there rises at intervals of about 7 ft. columns which carry, on stringers and cross floor beams, the roadway slab.

The complications in the layout are many. First, the curve of the river is such that none of the three rows of hinges is on a straight line and the spans vary in length progressively from the smallest at the upstream face to the largest at the downstream. Then it was desired to give the roadway a camber of 15 ins. to avoid the impression of a dip at the center. A transverse crown of 9 ins. was required on the roadway. The acute skew, the heavy camber, the obvious necessity for keeping the apex of the camber curve at the middle of length of each sidewalk, the grade of the approaches and the transverse crown of the roadway combined to produce a badly warped surface. In order to mitigate somewhat this extreme condition the transverse

Fig. 1 shows a typical side elevation of an arch rib with spandrel columns, floor beams and floor slab. As the dead load is very nearly uniformly distributed, the line of pressure due to dead load follows very closely the neutral axis of the parabolic arch rib and the reinforcement there is against live load stresses only. The ribs are 27 ins. deep at the springing and 24 ins. at the crown, with a gradual enlargement to 40 ins. at the middle in order to keep the total load pressure line well within the middle third. All ribs are 24 ins. wide. All ribs are heavily reinforced, as shown, by longitudinal rods and spaced vertical stirrups not against tension but to take compression and to add to the moment of inertia of the section without increasing the depth of the rib. The lower slab connecting the ribs is an integral part of the ribs, and is connected thereto with curved rods, which also act as reinforcement for the slab. The continuity of the adjoining members has

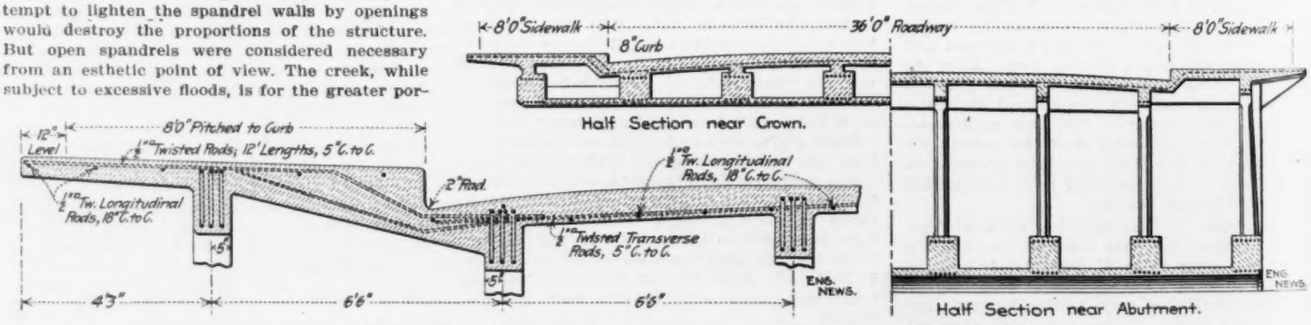


FIG. 2. SECTION THROUGH BRIDGE AND ENLARGED DETAIL OF SLAB.

been especially cared for, as an inspection of the reinforcement will show.

The spandrel columns are of the usual longitudinally reinforced type, with four ½-in. twisted rods extending down into the arch rib and up into the girders to make efficient connections. All inside columns are 10 × 10 ins. in section; outside columns are 10 × 13 ins. in lowest section, with a battered face bringing them to 10 × 10 ins. at the girder. The longitudinal girders are 10 × 12 ins. in section, reinforced in lower and upper flanges and well provided with stirrups and bracket connections. At every column

slope of the sidewalk was increased from ⅛-in. per foot at one end to ½-in. per foot at the other, the standard in the city being ¼-in. to the foot; the face of the curb was increased from 5¼ ins. at one end to 11¼ ins. at the other and the gutters were given different elevations at points immediately opposite each other. The appearance of the roadway finished in accordance with this arrangement is very satisfactory.

All structural parts are of reinforced concrete with plain square steel bars for the arch ribs and twisted square bars for all other portions of the work. As the 1¼-in. rods required for the

8 × 18-in. transverse beams are carried across the bridge from rib to rib, supporting, together with the longitudinal girders, a 7-in. floor slab. Fig. 5 shows the layout of the arch ribs and columns which latter, it will be noted, continue only part way up the arch rib, the middle portion of floor system being carried by cross-beams from the ribs. The lower soffit slab also stops about 11 ft. from the center hinge. The whole floor system at the crown is carried by a 10 × 18-in. girder set about 2 ft. back of the center hinge. The complicated scheme of forms for this floor system is well shown in the photograph reproduced in Fig. 8. Fig. 2 gives a transverse section through the floor showing the slab and also the 4-ft. cantilevered sidewalk.

Expansion in the upper works of the bridge is cared for by building in the abutment openings into which the longitudinal girders are set, first laying in the grooves sheets of heavy tar paper to ensure a separation and movement under temperature strains. The floor slab at the middle of the bridge is cut across by a ⅜-in. joint extending for the entire width of the bridge and the railing is provided with an expansion joint at the same place.

The hinges are shown in Fig. 5. As it was thought practically impossible to set pins with exactly parallel axes, it was deemed necessary to design hinges permitting some motion about an axis lying in the plane of the rib as well as about one perpendicular to this plane. The great difficulty experienced in getting the skewbacks properly set proved the wisdom of the design. At the abutments the hinges were held into the concrete by U-shaped anchor bolts. No anchor rods were used to connect the hinges to the ribs. In erection the two parts of each hinge were put up, tied together with the connecting bolts shown on the cuts. After the concrete had set these bolts were sawed apart.

The abutments consist of a thin reinforced face wall with heavy buttresses at each arch rib and full face walls (Fig. 7). Owing to extremely skewed position of the hinges the work at the skewbacks was rather complicated, as may be seen from the photograph reproduced in Fig. 4. Each abutment was founded on piles driven under the buttresses, nine piles to each buttress, with six piles inclined nearly parallel to the thrust and three vertical.

The centering for each arch rib was founded on a row of piles spaced about 9½ ft. apart, each pile carrying a 6 × 6-in. post, which supported 6 × 8-in. girders carrying in its turn the joist and lagging. These posts were held longitudinally by 2 × 8-in. plank X-braces, and from rib to rib by 3 × 8-in. planks used as plates on top of each pile and post respectively. The joists were of 3 × 14-in. timber and the lagging of 2-in. stuff. The centering was struck by wedges placed between the upper plate and the 6 × 8-in. girders. An interval of 18 days was left between the completion of the last arch rib and the striking of the centers. It was found that the greatest settlement at the crown of any rib was 0.075 ft. and the least 0.01 ft. Upon the self-supporting ribs the forms for the remainder of the superstructure were built.

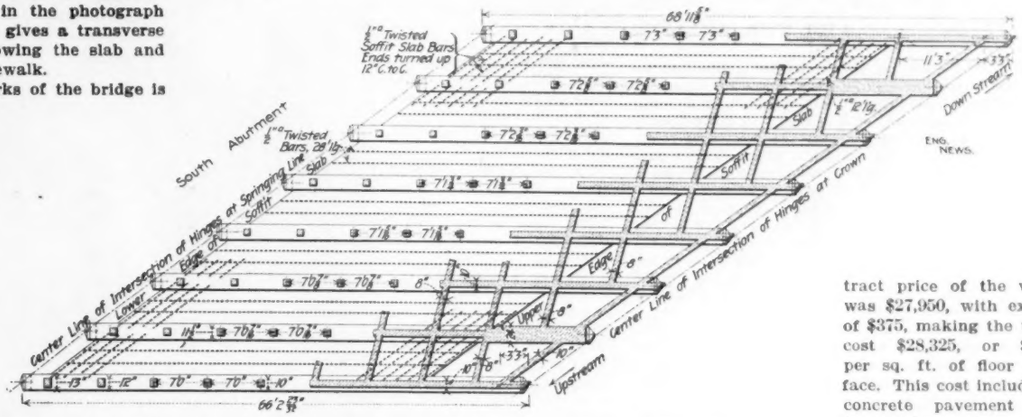


FIG. 3. HALF SECTIONAL PLAN OF RIB AND SOFFIT SLAB ON BANNOCK STREET BRIDGE, DENVER, COLO.

A view of the structure when it was near completion is shown in Fig. 9. On account of the angle at which the photograph was taken the foreshortening of the lines makes the bridge to appear much smaller than it really is. The surface of the work was left as it came from the forms, except that a few exceptionally rough pieces were floated with a thin coat of 1:1 mortar so that the entire exposed surface should have a uniform appearance.

All concrete used on the work was a 1:2:5 mixture of cement, sand and gravel, or crushed granite, the latter being used in the arch rib and the gravel in the remainder of the bridge.

The bridge was designed for a live load of 150 lbs. per sq. ft. of roadway and sidewalks uniformly distributed over the entire span or any portion of it. The floor system was designed for this uniform load or to carry a 20-ton road roller. The total dead weight carried by the ribs is 1,150 tons, or 323 lbs. per sq. ft. of floor, and the live load carrying capacity is 535 tons. With these loads a maximum compression of 600 lbs per sq. in. in the concrete is reached and a tension of 15,000 lbs. per sq. in. in the steel. This latter tension is not in the arch rib, where the steel acts only in compression.

The total quantities in the entire structure are 1,146 cu. yds. of concrete, 83 tons of reinforcing steel and 33,000 lbs. of steel castings. The contract price of the work was $27,950, with extras of $375, making the total cost $28,325, or $3.98 per sq. ft. of floor surface. This cost includes a concrete pavement for the roadway. This type has been found very satisfactory by the city on certain very heavily traveled street intersections and bridges.

The bridge was designed by Mr. Charles W. Comstock, M. Am. Soc. C. E., who furnished us the information and drawings which we herewith reproduce. The construction was carried on under the general supervision of the Consulting Engineer and of Mr. John B. Hunter, City Engineer of Denver, with Mr. George M. Post as resident engineer. The contractor was the Commonwealth Construction Co., of Denver.

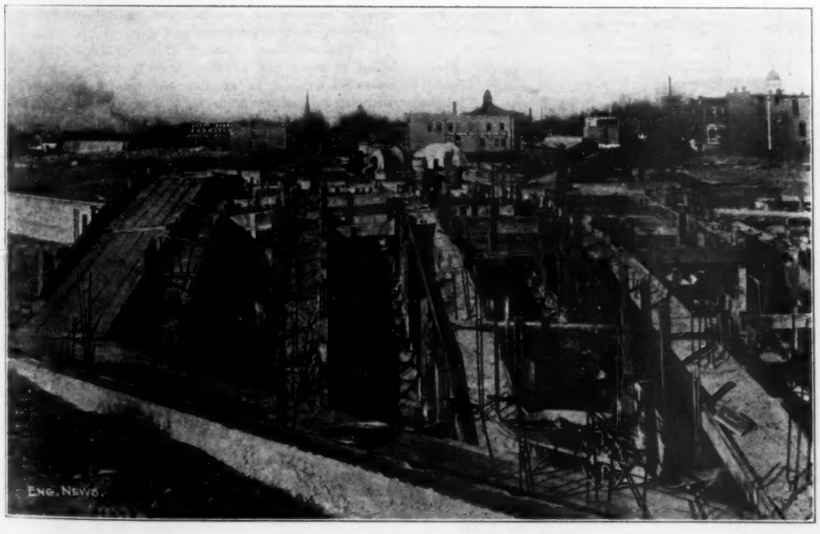


FIG. 4. VIEW SHOWING ARCH RIBS.

A 70-MILE DITCH, FLUME AND PIPE LINE, with a number of interesting features, is being built by the Yukon Gold Co. in the Dawson mining district, Dawson Territory, Canada, to supply water for placer mining. A dam has been built across Bonanza Creek at a cost of about $200,000. The ditch portion of the conduit is about 40 miles in length. Three depressions are crossed by inverted siphons of steel pipe 49 ins. in diameter and from ⅝ to ¾-in. thick. The total length of this pipe is 5½ miles, and the maximum head is at the crossing of the Klondike River, where the head is 1,100 ft. For lesser depressions, 49-in. California redwood stave pipe is used, banded with ½-in. round iron spaced 1¾ ins. c. to c. There are about 20 miles of flume 7 × 4 ft. in cross-section, constructed of native timber and supported for the most part on trestles. Where a ditch is used it is about 15 ft. wide on the bottom. Before beginning excavation it was necessary to strip the right-of-way for about 40 ft. in order to let the ground thaw out, but notwithstanding this, frost materially retarded the work. The ditch is being constructed by means of four steam shovels working at different points. As many as 1,400 men and 280 horses have been employed at one time. The men are paid at the rate of $28 per week, with board and lodging. It is expected that the conduit will be completed in the fall of 1908 if the material for the siphons is delivered in time, but there will still remain work to be done. The whole water supply system on completion will have cost some $2,500,000. The information here given has been taken from a special report by Mr. H. H. Rowatt, dated Sept. 30, 1907, to the Hon. Frank Oliver, Minister of the Interior, Ottawa, Canada.

CEMENT PRODUCTION IN 1907 at Roosevelt, Ariz., on the Salt River Project, U. S. Reclamation Service, is summarized in the March bulletin of the Service. The total output for the year was 42,145 bbls., at an average cost of $2.27 per bbl. This cost figure includes repairs, but no allowance for depreciation and none for any other capital charges. The mill was idle for over 4½ months, and when running was doing so at only a little more than half its normal capacity, both these conditions being due to the fact that the contractor could not use the cement any more rapidly and storage bins for both clinker and cement were not available.

COMMITTEE REPORTS: AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

The committee reports presented at the annual meeting of this association in Chicago on March 17 to 19, were too numerous and too extensive to allow extended abstracts of all of them in our columns. We give below, however, some of the principal features in the most important reports. Further notes of the various reports and discussions are given in our report of the convention proceedings, in the issue of March 26.

WOODEN TRESTLE BRIDGES WITH BALLASTED FLOORS.*

The ballasted floor of wooden trestle bridges had its inception in the desire to secure a longer life than that of the common wooden trestle with open deck; to decrease the cost of maintenance; and to obtain on roads bearing a heavy traffic a practically unbroken roadbed at points requiring openings under the track, where either a poor foundation or the difficulty of obtaining materials for a permanent structure makes the first cost of such a structure prohibitive. There are two general types of construction, one having the stringers separated and covered with plank to retain the ballast, and the other having the stringers so placed as to form a solid floor to carry the ballast directly. The present standards vary but slightly from those first adopted, the changes being more in detail than in the general designs.

All the timbers used in the construction of the first ballasted floor trestles were treated by the creosote process, the amount of oil injected being in nearly all cases 12 lbs. per cu. ft. of timber. The only exception is that of the ballasted floor wooden structure on the Michigan Central Ry., with a span of 14 ft., the timbers of which were treated with carbolineum avenarius. This structure was erected in September, 1899, and still has an estimated life of four years. It has not yet been necessary to renew any of the earliest ballast floor trestles. From the time of their construction, the estimated life of these bridges varies from 20 to 25 years, without repairs of any consequence. They first came into use in 1878, more were constructed in 1897, and the greatest number were built from 1901 to 1906. At present all predictions made regarding them are upheld, as no road reports having found it necessary to make any repairs of importance to ballast floor bridges, all the timbers of which were treated.

Plans typical of the two general designs of ballast floor trestles are submitted herewith, that of the Mobile & Ohio Ry., Fig. 1, [not reproduced—Ed.] showing the type (A) with separated stringers covered with plank flooring, and that of the Atchison, Topeka & Santa Fe Ry. system, Fig. 2, [not reproduced—Ed.] showing the type (B) with packed stringers. The estimated cost per lin. ft. of trestles of the two types, as constructed by different roads, is given in the accompanying table.

The committee is of the opinion that the former type of construction is the better for the following reasons: 1, The space between the stringers affords a better means of inspection of the stringers, which becomes increasingly necessary as the trestle nears the end of its life. 2, When repairs, renewals or changes become necessary, they may be made more easily and at less cost. The stringers should preferably have a length equal to the distance c. to c. of bents, plus the width of the cap, but the outside stringers should have a length equal to two spans, and should break joints over alternate bents. The ideal ballast consists of broken stone that will pass through a 2-in. ring; next, in order, clean gravel that will be held on a ½-in. screen; and after that, unscreened gravel, chats and sand ballast.

The bents of ballasted floor trestles do not drift with the direction of heaviest traffic, and no more difficulty has been experienced with track creeping on them than is ordinarily experienced with track supported by similar ballast on the ordinary roadbed. Ballasted floor trestles undoubtedly decrease the danger from fire and will probably never catch fire unless it is communicated to them at their base, where they are as vulnerable to fire as any other wooden trestle.

The merits claimed for the ballast floor trestle may be summarized thus: Long life, small cost of maintenance, practically continuous roadbed, easier riding track which may be lined and surfaced by section labor, decreased danger from fire and greater safety in case of derailment. The claim relating to long life and small cost of maintenance will probably not be sustained unless all of the timbers in the trestle are properly treated with an effective preservative. The disadvantages of ballast floor trestles to which attention has been called are the following: Difficulty of obtaining properly treated timber, great first cost of construction, possible and probable excessive cost of maintenance when the structure becomes old, difficulty of careful inspection of the vital parts of the structure, difficulty of making repairs and renewals and their probable excessive cost, and doubt as to the ultimate economy of their use. In the absence of authoritative information on the final cost of maintenance and of renewals, the committee cannot make a definite computation on the economic merits or demerits of the ballast floor trestle.*

*From the report of the Committee on Wooden Bridges and Trestles.

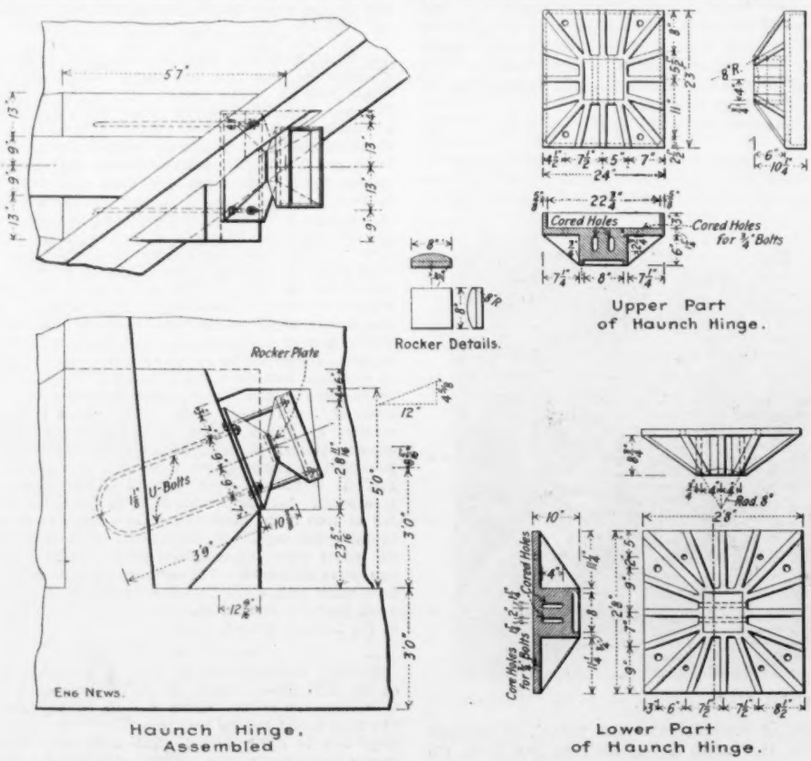


FIG. 5. DETAILS OF HINGES ON CONCRETE ARCH AT DENVER.

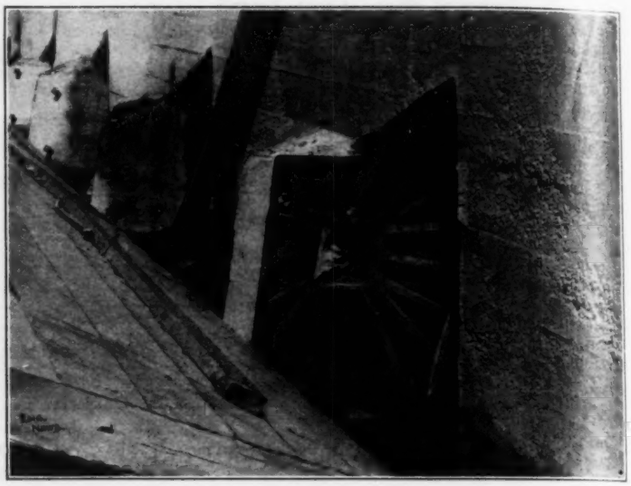


FIG. 6. VIEW OF HINGE.

SAFE CARRYING CAPACITY OF RAILWAY BRIDGES.†

A preliminary report on this subject, by Mr. A. J. Himes, a member of the committee, fully describes the unknown quantities pertaining to a considerable extent in new bridges, and to a still greater extent in old bridges; and the ability, experience, sound judgment and nerve required of an engineer when he faces the responsibility of deciding to what extent he can safely overload his bridges. Owing to insufficient knowledge as to the actual effects of fast-moving trains on bridges, the uncertainties as to the actual strains which may exist and the varying condition of the other controlling factors, each bridge must be considered as a separate problem. Therefore it is impossible to formulate any general rule for universal application in determining the maximum safe carrying capacity.

The question is mainly one of conditions, experience and judgment, and judgment must be based upon the conditions, so far as they are known, and upon experience with overloaded structures under approximately similar conditions. While unwilling to submit any positive general statement as to the absolute limit of overload or limit of strains which may be permitted, the following specific conclusions are believed to be conservative and consistent with experience and general practice:

1. The carrying capacity of a bridge is here understood to mean the heaviest moving loads which may be operated over it in regular service for a limited time without subjecting it to such severe strains, motion or wear of parts as to seriously impair its safety and serviceability.

2. The carrying capacity of any bridge will depend upon a large number of controlling factors, all of which must be taken into consideration. Some of these factors are design, material, workmanship, speed, strains, behavior, physical condition and the possibility of maintaining falsework for a considerable time should the bridge show distress under increased loading.

3. A railway bridge which has been constructed in accordance with a specification which provides for strength, design, material and workmanship at least

*In an appendix to the report Mr. A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Santa Fe Ry. system, says that roads using open-deck bridges pay more per lin. ft. per annum than for ballasted-deck structures, even though the first cost of the open deck may be the lower. His comparisons show that it is best to use ballasted-deck structures, even if they do not materially reduce or absorb the effects of impact.—Ed. Eng. News.

†From the report of the Committee on Iron and Steel Structures.

Table of Cost of Ballasted-Floor Trestles.

Railway.	Avr'ge height.	10 ft. high.	20 ft. high.	30 ft. high.
(A) St. L. & S. E., first plan.	$15.00	.....	.....	.....
(A) St. L. & S. E., present standard	17.70	.....	.....	.....
(A) L. & N.	15.00	.....	.....	.....
(A) I. C., four pile bents	.....	$13.50	$15.50	$16.60
(A) I. C., six pile bents	.....	15.20	17.80	19.30
(A) N. C. & St. L.	.....	16.40	18.00	22.00
(A) E. P. & S. W.	.....	18.50	20.50	23.00
(A) O. S. L., U. P. and So. Pac.	12.75	.....	.....	.....
(A) C. R. I. & P.	.....	22.86	24.74	27.91
(A) M. & O.	14.00	.....	.....	.....
(B) A. T. & S. F., before 1905	16.00	.....	.....	.....
(B) A. T. & S. F., 1905 and after	18.00	.....	.....	.....
(B) Southern Ry.	.....	15.00	16.60	18.50

equal to the standard of this Association's specifications will, when in good condition, carry for a limited period a loading in excess of that for which it was originally designed. The bridge, however, will be subjected to a greater amount of motion and wear of parts, have a lower margin of safety, less efficiency and a shorter life.

4. When the span is less than 200 ft., all controlling factors given in Article 2 good, the mathematical analysis made in accordance with the Association's specifications of 1906, using full specification allowances for impacts for regular service, fast speed and half of these impact allowances for slow speed, then, so long as the controlling factors remain good, unit strains in tension to the extent of 26,000 lbs. in structural open-hearth steel and 22,000 lbs. in wrought-iron, will not, in themselves, be sufficient justification for suspending traffic or condemning the structure.

5. When the controlling factors as outlined in Article 2 are not good, the limiting strains or capacities cannot be determined by any general rule, as they are questions of actual conditions, judgment and experience, supplemented by a close watch on the structure in service.

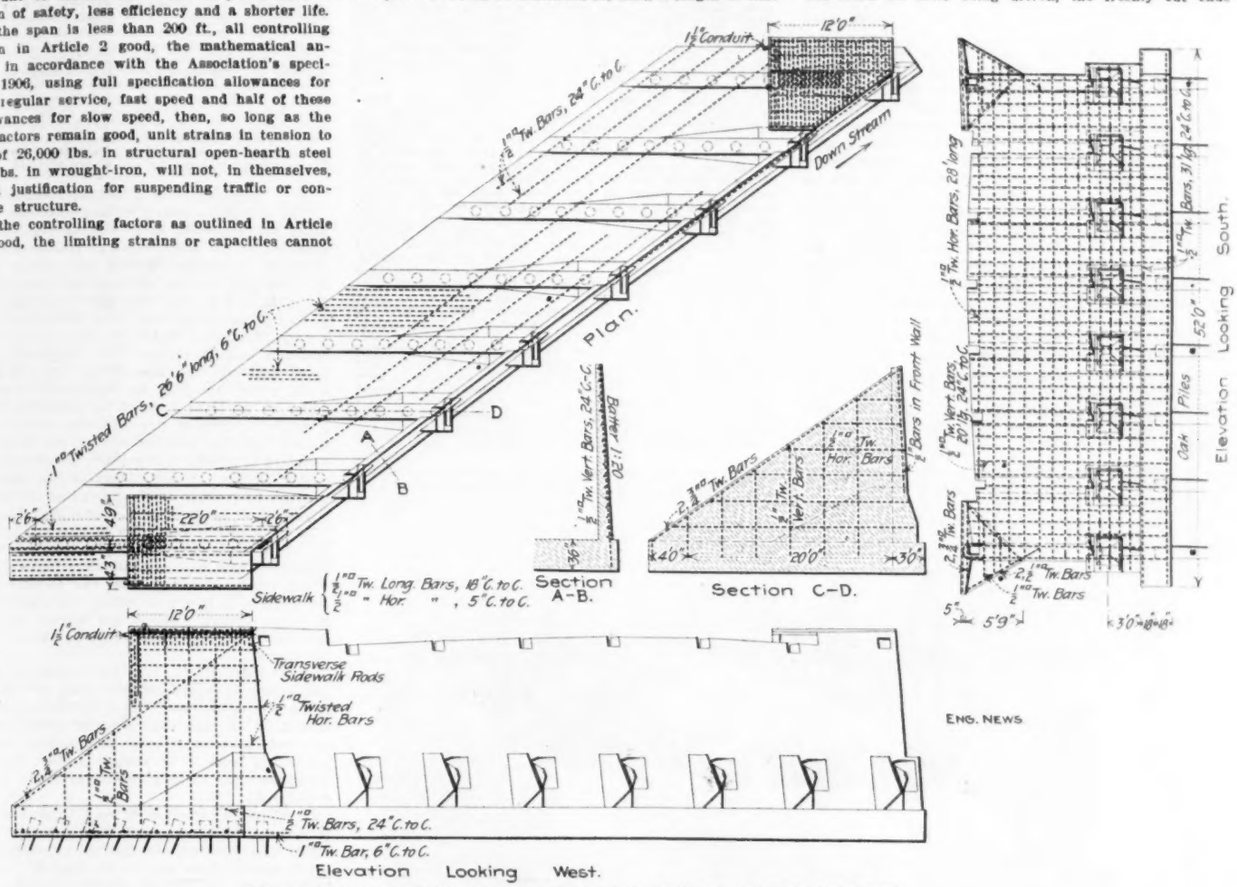


FIG. 7. GENERAL PLAN OF ABUTMENT ON BANNOCK STREET BRIDGE.

THE PRESERVATION OF STRUCTURAL TIMBER.*

In conference with the Committee on Ties, it was the unanimous opinion that in the present state of the art, only the creosote treatment of timber for bridges and similar structures should be considered. For pile and trestle bridges it is recommended that the treatment apart from the piles be confined to ballasted floor spans, partly on account of the increased danger from fire during the early life of treated timber, and partly on account of the fact that a sufficient supply of creosote does not appear to be conveniently available at present for the general treatment of all bridge timber.

Experiments on the strength of treated timber have been made by Mr. Wm. Hood, Chief Engineer of the Southern Pacific Ry., and by Dr. W. K. Hatt. Mr. Hood's experiments indicated a considerable decrease in strength, due to treatment, the method employed on the experimental sticks being similar to that given in the specifications of the Atchison, Topeka & Santa Fe Ry. for the treatment of Douglas fir. The results were regarded as so unsatisfactory that Mr. Hood abandoned the treatment of stringers for pile trestle bridges. The results of the more recent tests by Dr. Hatt are summarized in his report as follows:

1. A high degree of steaming is injurious to wood. The degree of steaming at which pronounced harm results will depend upon the quality of the wood and the degree of seasoning, and upon the pressure (temperature) of steam and the duration of its application. For loblolly pine the limit of safety is certainly 30 lbs. for 4 hours, or 20 lbs. for 6 hours.

2. The presence of zinc chloride will not weaken wood under static loading, although the indications are that the wood becomes brittle under impact.

3. The presence of creosote will not weaken wood of itself. Since apparently it is present only in the openings of the cells, and does not get into the cell walls, its action can only be to retard the seasoning of the wood.

The cost of treatment, exclusive of the cost of creosote, varies from 5 to 8 cts. per cu. ft. At places on the Atlantic and Gulf coasts the cost is about 1¼ cts. per lb., including an allowance for waste. This corresponds to a cost of 8 cts. per gallon at the places mentioned. Whenever possible, green or water-soaked timber should be seasoned before treatment, and when seasoned, steaming is not only unnecessary, but should be avoided. In some climates seasoning is impractical, owing to the rapid decay of the timber. When steaming is necessary the process should be continued for such a length of time as to insure proper penetration, but in no case should the pressure exceed 35 lbs. per sq. in. or the steaming be continued long enough to injure the strength of the timber.

The kinds of commercial bridge timber which are suitable for treatment include long-leaf yellow pine (to be used for piling only where special strength is required), short-leaf and loblolly pine and Douglas fir; also, probably, Norway pine, tamarack and hemlock, although little is known of the creosote treatment of these woods. In selecting timber for treatment a large percentage of sapwood is desirable. Whenever possible all framing and boring should be done before the timber is treated. Where this is not possible, as where piles are sawn off after being driven, the freshly cut ends should be thoroughly painted with at least four coats of hot creosote.

The quantity of creosote to be specified should vary with the proportion of sapwood to heart and the following quantities given should be considered only as averages. For marine exposure, on the Atlantic coast north of Delaware Bay, 12 to 15 lbs. per cu. ft.; south of Delaware Bay, and on the Gulf and Pacific coasts, 20 to 25 lbs. per cu. ft. The Norfolk Creosoting Co. makes the following recommendation: north of Portland har-

*From the report of the committee on Wooden Bridges and Trestles.

FIG. 8. VIEW SHOWING FORMS FOR BEAMS AND GIRDERS.

bor and along the coast of Nova Scotia not less than 16 lbs.; from Portland harbor to Delaware Bay, 12 lbs.; Hampton Roads, 16 lbs.; the balance of the Atlantic coast to Florida, 20 lbs.; the north shore of the Gulf of Mexico, 20 to 22 lbs.; the south shore of the Gulf from Vera Cruz to Panama, 25 to 30 lbs.; on the Pacific coast, south of San Francisco, 25 lbs., and north of San Francisco, 20 lbs. The Pacific Creosoting Co. recommends 16 lbs. per cu. ft. for Puget Sound work. For interior localities, the committee recommends for places north of the latitude of Memphis, 12 lbs., and south of that, 15 lbs. per cu. ft. The penetration should not be less than 1½ ins. for 12 lbs. per cu. ft., or to the heartwood when there is a smaller depth of sapwood, and a corresponding increase in depth for greater quantities, the penetration being determined by borings as previously described.

For long-leaf, short-leaf and loblolly pine, Norway pine and tamarack, the timbers should be treated in enclosed cylinders, and when green or water-soaked should be subjected to the action of live steam at a pressure not exceeding 35 lbs. per sq. in.; corresponding to a temperature of 280° F. As soon as the chamber is cleared of all sap and water by drawing off at the bottom, a vacuum of not less than 20 ins. should be maintained for a period of from 5 to 8 hours or until the discharge from the vacuum pump has no odor or taste. The chamber then being emptied of water and sap, oil is admitted at a temperature of 140° F. until the entire chamber is filled with oil. Pressure should then be applied until the required amount of oil is absorbed.

FIG. 9. BANNOCK STREET BRIDGE ACROSS CHERRY CREEK, DENVER, COLO.

For the treatment of Douglas fir, the specifications of the Atchison, Topeka & Santa Fe Ry. are recommended, and are printed herewith:

SPECIFICATIONS FOR CREOSOTING PACIFIC COAST PILING AND TIMBER: A., T. & S. F. RY.

1. Piling (Water-Soaked).—The piling to be treated must be Douglas fir, conforming to the specifications for this class of material. Each cylinder charge must be made up of piles which have been in the water as nearly as possible the same length of time; nor must they have been so long therein as to cause deterioration or damage of any kind, but at time of treating must be thoroughly sound, free from sea-worm holes and limnoria; also from barnacles and the like.

2. After the piles are placed in the cylinder they must be immersed in creosote oil of a temperature ranging between 160° and 170° F., and kept covered during the entire boiling period under at least 4 ins. of oil at the shallowest place. The engineer on duty must from time to time during the boiling satisfy himself, by bleeding the cylinder, that such is the case.

3. After filling the cylinder with oil, steam must then be regulated through the heating coils so that the temperature within the cylinder is kept gradually rising as fast as the condensation will permit until 220° F. is reached; after which the steam pressure must only be such as to maintain a regular and constant temperature within the cylinder, with 220° as the minimum and 225° the maximum, until such time as the amount of condensation per cu. ft. per hour collecting in the hot well of the condenser shows the interior of the wood to be thoroughly dry, when the steam pressure in the coils should be released, and the cylinder filled up with creosote oil from the storage or working tank, of a temperature ranging between 160° and 170° F. Then pump pressure applied until the gage shows 5 lbs. pressure in the cylinder (this to insure the fact of the cylinder being actually full), after which the connection between storage tank and cylinder should be closed and the connection between measuring tank and cylinder opened. Additional pressure must then be applied until the piling has taken the proper amount of oil, forced in under such conditions as will insure its complete retention in the wood after drip is over, and figured at the weight of the dry oil per gallon at 165° F. The cylinder doors may then be opened provided the temperature within is reduced below 200° F.

4. After treatment, the piling must be free from all heat checks, water bursts, and other defects due to inferior treatment which would impair usefulness or durability for the purposes intended. Piles when bored midway between the ends must show no moisture in to the center, and the borings beyond the oil penetration must retain their natural elasticity and strength. The penetration of black oil midway between the ends, for a 10-lb. treatment, should be at least ¾-in. in piles up to 40 ft. in length; 1 to 1¼ ins. for piles between 40 and 70 ft. in length, and 1¾ to 1½ ins. for piles 70 ft. and over; with a correspondingly greater depth for an increased quantity of oil.

5. Green and Seasoned Piling.—Green or freshly cut piles, delivered at the treating plant on cars, or any which have not been lying in the water, must be treated in the manner prescribed for green or freshly sawed material. Thoroughly seasoned piles must be treated in the manner prescribed for thoroughly seasoned sawed material. No piling in these two classes must be mixed together and treated in the same charge.

6. Douglas Fir Sawed Material.—Seasoned and green or freshly sawed material must not be mixed together and treated in same charge, and none should be treated which is not at the time free from rot and in proper condition for use after treatment so far as splits or breaks are concerned. If any such is received from the mills it should not be treated unless the inspector directs it to be done. Square timber must not be treated in the same charge with planking, nor ties with planking, and sufficient 1-in. strips must be placed between each tier, with from ½-in. to 1-in. space left between each piece, so that the oil can have free access to all surfaces. After the material is placed in the cylinder, it must be immersed in creosote oil of a temperature ranging between 160° and 170° F. and kept covered during the entire boiling or heating period under at least 4 ins. of oil at the shallowest place; the engineer on duty must from time to time during the boiling satisfy himself, by bleeding the cylinder, that such is the case.

7. In the case of green or freshly sawed material, steam must thereafter be regulated through the heating coils so that the temperature within the cylinder is kept gradually rising as fast as the condensation will permit until 212° F. is reached, with 215° F. as the maximum; after which the steam pressure must only be such as to maintain a regular and constant temperature within the cylinder between these figures, until such time as the amount of condensation per cubic foot per hour collecting in the hot well of the condenser shows the interior of the wood to be thoroughly dry, when steam pressure in the coils should be released. In the case of thoroughly seasoned material, the temperature of the oil in the cylinder must be allowed to rise slowly and steadily until 190° F. is reached, with 192° F. as the maximum, and kept between these figures until such time (dependent upon the dimensions) as the interior of the wood shall have become sufficiently warmed up to enable it to take the required amount of oil, when the steam pressure in the coils should be released.

The cylinder should then (in each case) be filled up with creosote oil from the storage or working tank, of a temperature ranging between 160° and 170° F., and pressure from the pump applied until the gage shows 5 lbs. pressure in the cylinder (to insure the fact of the cylinder being actually full), after which the connection between storage tank and cylinder should be closed, and the connection between measuring tank and cylinder opened. Additional pressure must then be applied slowly and steadily until the material has taken the proper amount of oil, forced in under such conditions as will insure the complete retention in the wood after drip is over, and figured at the weight of the dry oil per gallon at 165° F. The cylinder doors may then be opened provided the temperature within is below 200° F.

After treatment the material must be free from all heat checks, water bursts and other defects due to inferior treatment, which would impair usefulness or durability for the purposes intended. The penetration of black oil midway between the ends for a 10-lb. treatment should be at least ¾-in. on dimension timber, and on planking at least ½-in.; with a correspondingly greater depth for an increased quantity of oil.

Before each cylinder charge is disposed of, the depth and character of the penetration must be ascertained by boring one or more auger holes after the wood has cooled, in as many pieces of each class of material as may be necessary for the purpose; and such pieces as are not found to be fully treated in accordance herewith must be returned to the cylinder with a subsequent charge for further treatment without extra cost therefor; should more than 10% of the total number of pieces treated be found defective, the entire charge must be so returned. No material must be removed from the treating yard until all auger holes are tightly plugged with creosoted plugs.

The intent of these specifications is that the wood, when it comes out of the cylinder and after all drip is over, shall contain the full weight of oil to the cubic foot, forced in at such pressure and under such conditions, as to enable the wood cells and fiber to retain it permanently; but as there is more or less rebound of oil out of the wood after pressure is released, a checking up of the oil on hand against the total contract absorption of the various charges shall be made [illegible] hours, timber and piling being kept separately. If any difference is found to exist, a coefficient shall be established and used until the next checking shows the necessity for a different one.

The oil must be a pure dead oil of coal tar without adulteration, with a specific gravity of 1.04 to [illegible] at a temperature of 60° F.; it must be perfectly fluid at 100° F. and remain so on cooling down to 60°. The distillation must be conducted under the method published in Bulletin No. 65 of the American Railway Engineering and Maintenance-of-Way Association, and of the dry oil, the boiling point shall be: Up to 210° C. not more than 5% and between 210° C. and 235° C. not more than 30% shall distill over, while at 355° C. at least 90% shall distill over. As a different method of distillation is used abroad, sufficient allowance must be made in these percentages for imported oil to bring it within specified limits when analyzed by the above method.

LOCOMOTIVE COALING STATIONS.*

Your committee desires to emphasize the need of adequate fire protection at all coaling stations and to call attention to the possibilities of reinforced-concrete construction of coaling stations and storage bins (which has been used in some instances) as a method of reducing fire risk, and at the same time securing structures of greater permanency than those ordinarily in use. The average insurance rates for open trestle timber construction coaling stations and reinforced-concrete fireproof structures are, respectively, 1% and 0.25%. This would mean that from the standpoint of fire insurance alone we would be justified in expending 15% more for a reinforced-concrete structure than for a timber coaling station. As the relative cost of the fireproof style of structure at present is about 40% above that of the heavy timber station, an expenditure of the extra 25% may, perhaps, be justified on the ground of the smaller chance of incidental losses due to interruption of traffic.

To the general information in last year's report should be added that the balanced two-bucket type of coal elevator is now built with auxiliary horizontal conveyors, which receive the coal from the elevator buckets and distribute it to bins and pockets, thus adapting it to use in larger coaling stations and storage plants than are practicable for the simple balanced bucket type of coaling station.

CONCLUSIONS.†—1. It is not possible to give absolute limits between which different types of coaling arrangements are to be used. Each installation must be considered as an individual problem. Prices of materials, cost and character of labor, the possible track arrangements, the amount of storage desired, the power and attendance, and shifting service available, all are to be considered.

2. Where the quantity of coal handled is small, particularly at terminal points where locomotives lie over night, it is recommended that the locomotives be coaled, either directly from cars by the hostler, or by handling from cars to an elevator platform provided with a jib crane and 1-ton buckets, and from these buckets to the locomotive.

3. At terminals where the daily consumption of coal does not exceed 75 tons, a locomotive crane with clam-shell bucket is desirable, provided that there is at such terminal other work that can be economically performed by the locomotive crane.

4. At terminals where the requirements are from 75 to 200 tons per day and a deep foundation is practicable a balanced two-bucket hoist type of coaling station is recommended.

5. For terminals larger than those previously considered, the type of coaling station which should be selected as most desirable is dependent entirely upon local conditions. Where it is required that coal be delivered to not more than two tracks and where the necessary ground space is available, a coaling station of the trestle type, with incline approach, is recommended. In yards where delivering locomotives are constantly in attendance a plant with a 5% incline is preferable to one with a 20% grade operated by a hoisting engine. Where it is required to deliver coal to more than two tracks, or where the ground space for the trestle type is not available, a mechanical conveyor type is recommended.

REINFORCED-CONCRETE ROUNDHOUSES.‡

In economy of first cost, durability and fire-resisting qualities, there is no fireproof roof construction which is equal to reinforced concrete. The reinforced-concrete roof must be covered with some suitable roofing to keep it water-tight, substantially the same as for a wooden roof. There are water-proofing preparations to be mixed in concrete for concrete roofs, but your committee is not prepared to recommend their use.

If the roof is of reinforced concrete it should be supported by columns of the same material in the outer and end walls, as well as in the interior of the building. These columns should be concreted with the roof, the concrete being run into the forms from above. The columns on the inner circle, to which the doors are attached, should be preferably steel or cast-iron.

*From the report of the Committee on Buildings.

†The conclusions of the report for 1907, with an abstract of that report were given in our issue of March 28, 1907.

‡From the report of the Committee on Buildings.

To support a wooden roof, wooden posts are recommended, except that, in warehouses in which the outer and end walls are of brick or concrete, for the roof supports in such walls, pilasters of the same materials are recommended.

The design adopted by your committee as a basis for comparative estimates requires as much window space as possible. This, except for end walls, leaves no curtain wall to be provided, except for the space between window sills and floor and a narrow strip around the three other sides of each window. The cost of the walls in comparison with the total cost of the building is relatively unimportant For a structure roofed with reinforced concrete, the curtain walls may be of brick, plain concrete, reinforced concrete or plaster. The brick will generally be found to be more satisfactory and a little cheaper than concrete. Concrete will, however, if properly made, give good service and local costs of materials and labor would ordinarily determine which of the first three styles of curtain walls should be built. The plaster curtain wall may be used where it is desirable or necessary to reduce the first cost to a minimum. To build such a wall, Portland cement is mixed with enough lime, so that it can be worked with a trowel and is plastered on expanded metal. The latter is stiffened with rods and with channel irons, which are used to support the window frames. A wall of this character can be built more quickly than a concrete wall, is efficient and should be durable. If damaged by a locomotive or otherwise, it is easily repaired, and alterations can be readily made. Used with concrete columns, it should not crack, and its first cost is but about half that of a brick wall.

The cost of concrete construction in roundhouses depends largely upon the number of times the forms can be used: It follows, therefore, that where the structure is large and the forms for each unit or stall can be used many times in the same roundhouse, the cost per stall is much less than in a small building. Consequently reinforced concrete construction is more economical in large than in small roundhouses, when compared with brick or frame construction.

1. Reinforced concrete should be used below the floor when it is cheaper than plain concrete.

2. The additional security against interruption to traffic warrants the construction of a roundhouse with a reinforced concrete roof.

3. When the roof is of reinforced concrete the columns, except those supporting doors, should be of the same material.

4. Reinforced concrete should be used for the walls only where special conditions reduce its cost below that of brick or plain concrete and where plaster is not considered satisfactory.

5. Jib cranes attached to outer posts alongside of a number of pits in roundhouses, or, in the case of large roundhouses, a trolley hoist working around the outer circle, capable of handling two tons, should be installed in such roundhouses as may be designated by the motive power department as requiring such appliances for light locomotive repairs.

6. The disadvantages of roof lights in roundhouses are so much greater than their advantages as to make them undesirable.

7. Windows in the outer walls of roundhouses should be made as large as practicable and contain the largest glass or light area consistent with the requisite strength. In general, the lower sill should be not more than 4 ft. from the floor and only sufficient space left between pilasters and sides of window frames, and girders and window heads to properly secure the window frames. Windows or transoms as large as practicable should be provided over all doors where locomotives enter.

RIGHT-OF-WAY MAPS AND TRACK MAPS.*

Right-of-way maps should show the state, county, township, town or city; the right-of-way alinement complete; the station plusses of the crossing of all important land or property lines and streets, with the distance to all permanent land or street corners; the angle which the center line of the road makes with property lines; the number of the right-of-way sheet; the points of the compass; the scale and date of the map; the boundaries of the several parts of the land owned by the company, and the width of the right-of-way, particularly at those points where the widths change. Any additions, or subdivisions of towns or cities, with numbers and sizes of lots and blocks, and names of streets. It should also show all main tracks, sidetracks and structures that were built in connection with the original construction of the road; and the exact location of all crossings of steam, electric or other roads.

On or near each part of the land on the right-hand side of each map should be shown the deed custodian's number; the name of grantor and grantee, mileposts, kind of instrument, date, and book and page where recorded. This also includes reference to leases, franchises, ordinances and grants concerning the use of land.

It is important to show on the original right-of-way map a profile of the same horizontal scale and of the same station numbers as the map and of suitable vertical scale. This profile should show the original subgrade, the location, character and size of opening of each bridge, waterway or under-crossings, and the original surface of the ground. The necessity for this is the knowledge of physical conditions at the time the road was built, often needed in defending litigation and settling questions arising from time to time. In regard to the scale, a range of from 50 ft. to the inch to 400 ft. to the inch should cover all possible conditions, except, possibly, in undeveloped portions of the country, where a smaller scale could be used.

Track maps should show all physical conditions, pertaining to the construction and operation of the railway and the limits of the right-of-way without reference to title or ownership. They should show all main and sidetracks and their alinement, distance between them, capacity and car lengths. All buildings upon the right-of-way and adjacent thereto, dimensions and character thereof, and location with reference to main or sidetracks. Bridges, culverts, water stations, coaling plants, turntables, shop buildings, water mains, electric light wires, fences, street car and other railway crossings, and the angle they make with the railway track. Sewers, signals of all kinds and all physical conditions on the property. All structures on such maps should be located by chainage numbers and plusses.

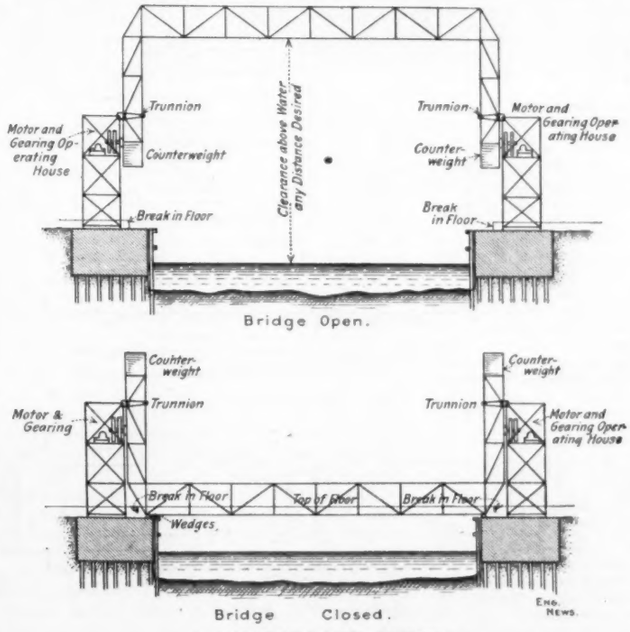
A scale of 100 ft. to the inch should be used except in territories and cities of large industrial development, where varying scales may be used to suit the local conditions. The conventional signs adopted by the association, should always be used where it is possible and convenient to do so.

*From the report of the Committee on Records, Reports and Accounts.

A GYRATORY LIFT BRIDGE.

A drawbridge of novel type has recently been patented by Mr. Eric Swensson, of Minneapolis, Minn., with the intention of applying the design to a bridge across "The Narrows," on Lake Minnetonka, near that city. The construction is not yet assured, but the bridge is of so peculiar a pattern that a brief description may be of interest.

The accompanying figure will serve to illustrate the principle of the operation of what Mr. Swensson calls the "Gyratory Lift Bridge." It consists of a pony truss or plate girder span suspended by trussed hangers from trunnions bearing on towers at each abutment. The draw is opened by revolving the main roadway trusses in an arc around the horizontal longitudinal axis marked by the trunnions. The upper portion of the trussed hangers carry counterweights equal in weight to the suspended structure so that the friction and wind are the only forces against which the machinery must act. Motors and racks are placed on the towers as shown so as to control directly the turning of the span. When the bridge is in its normal condition wedges are placed under the extreme ends so that the weight can be carried directly to the abutments and not through the hangers to the trunnions.



A GYRATORY LIFT BRIDGE.
(Invented by Mr. Eric Swensson, Minneapolis, Minn.)

In his design for the Minneapolis bridge Mr. Swensson has covered the framework of the towers and of the hangers with ornamental iron, relieved with cornices, arches and molds, continuing the same motive across the opening between the hanger and the tower so as to simulate a unit structure. This would seem to be a mistaken effort toward decoration not only because of the incongruity of ornamental iron imitation of masonry, but because the very operation of the bridge as a draw must emphasize the separation of the hanger and the tower. Any effort to make such a structure ornamental will probably result in failure. It would be far better to let it frankly express that which it is, a structural steel construction.

AN ADDITIONAL WATER SUPPLY for Wheeling, W. Va., from wells sunk in the bed of the Ohio River, has been recommended by a citizens' committee. The recommendations are based in their specific points on the report made to the committee by Mr. G. L. McKibben, Consulting Engineer, of Van Wert, Ohio. The scheme includes a 48-in. suction main 4,000 ft. in length, from the outer portion of which nine branches, each 275 ft. long, would extend nearly to mid-channel of the river. Each of these branches would connect with eleven wells by means of short 8-in. sub-branches. Each of the wells would be 8 ins. in diameter, and a typical well would be 34 ft. in pipe depth, extending to and a few inches into rock. The lower 6 ft. of each well would apparently serve merely as a support for a strainer section 10 ft. in length, the top of the strainer thus being 18 ft. below the cap of the well. The cap in turn would be 3 ft. below low water in the river, and the branch mains of the suction main would also have their tops 3 ft. below low water. The wells would first pass through 5 ft. of gravel, sand and silt, then through 10 ft. of coarse gravel and sand, and finally through 7 ft. of gravel and sand. The estimated cost of the 99 wells, with pipe connections and suction main, is $110,000. The committee also recommends a new 20,000,000-gal. pump at a cost of $140,000, and a new pump well and building at a cost of $50,000. The report states that the gravel bed in which it is recommended that the wells be sunk is a part of a large bed shown on the geologic map of Ohio County as Pittsburg gravel. The report contains references to a number of similar supplies drawn from wells in the bed of the Ohio River. These references include bacterial analyses showing thousands of bacteria in the river water and a nearly sterile well water, the inference to be drawn being that the two waters are practically identical except as to the purification effected by the passage of waters through the sand and gravel to the wells. Mr. George J. Rogers, of Wheeling, W. Va., was secretary to the citizens' committee which made the report under review, and Mr. C. C. Smith was employed as engineer, in addition to Mr. McKibben.

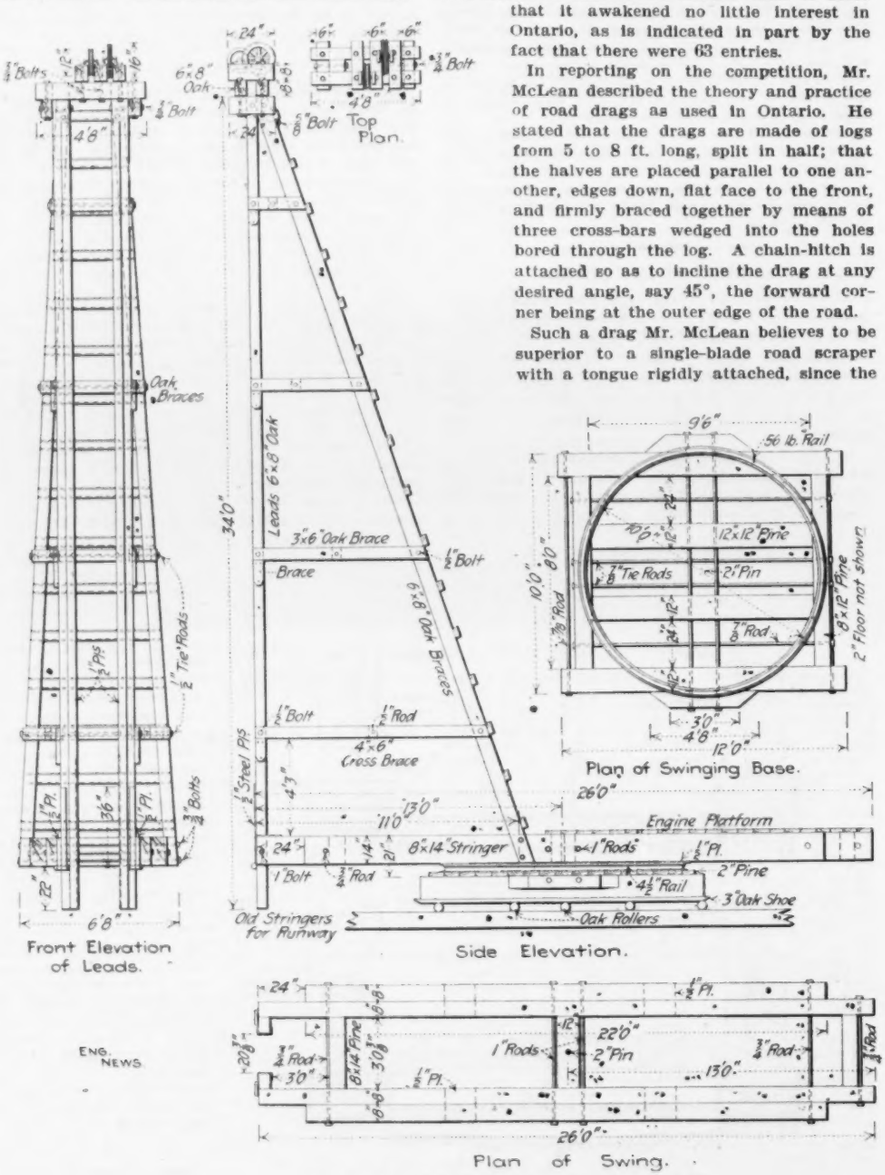
LEGISLATION FOR MUnicipal contract work in Illinois is to be sought by contractors engaged in that class of work. One purpose is to secure legislation providing that such contractors must be licensed. It is also desired to secure a change in the present law regarding municipal bonds issued in payment for contract work. The bonds do not always realize their face value, but are sold at a discount, so that the contractor cannot tell what amount he will receive. A permanent organization has been effected, under the name of the Illinois Association of Municipal Contractors: President, Mr. John E. Bretz, Springfield, Ill.; Secretary, Mr. A. F. Dunlap, Edwardsville, Ill.

A REVOLVING PILE-DRIVER.

We have in the past published descriptions of pile-drivers so pivoted that they can be revolved in a horizontal plane without moving the whole machine; but as these articles were published several years ago and the issues containing them are long out of print, we give space here to another driver of this sort recently built by Wortham & Washington, Civil, Municipal and Irrigation Engineers, at Greeley, Colo.

The driver shown in the accompanying illustration was built in five days by eight men for use in driving 26-ft. cedar piles about 24 ft. below the bed of a stream. The drawing is self-explanatory. The leads and braces are of 6 × 8-in. oak, the leads being lined with ½-in. steel plates. The lead swing or upper platform is of old 8 × 17-in. stringers sawed to a 14-in. depth and cross-braced with 12 × 12-in. pine sticks through which, at the center, a 2-in. king-pin is fastened to the lower or fixed platform base. This base is made of 12 × 12-in. pine held with ⅞-in. bolts, with a floor platform of 2-in. plank to which old 56-lb. rails are fastened in a 10-ft. circle. Steel plates ½ in. thick are fastened to the under side of the upper platform, sliding on these curved rails when the upper works are revolved by means of ropes fastened at the rear end of the swing brace, passing around the circular rails to the engine. A 2,400-lb. hammer is used with the machine.

Somewhat similar pile-drivers have been illustrated in Engineering News as follows: Columbia River jetty work, Apr. 18, 1891. vol. 26, p. 368; Yaquina Bay, Ore., jetty work, July 13, 1893, vol. 30, p. 39; New Orleans drainage system, Aug. 9, 1900, vol. 44, p. 87.



A REVOLVING PILE DRIVER.

(Designed and Built by Wortham & Washington, Civil, Municipal and Irrigation Engineers, Greeley, Colo.)

SPLIT-LOG ROAD DRAGS IN ONTARIO.

We are indebted to Mr. W. A. McLean, Engineer of Highways of the Province of Ontario, for an account of a split-log drag competition carried out in Ontario in 1907. The competition was fathered by the "Farmer's Advocate," and Mr. McLean acted as judge. The competition itself need not concern us further than to state that it awakened no little interest in Ontario, as is indicated in part by the fact that there were 63 entries.

In reporting on the competition, Mr. McLean described the theory and practice of road drags as used in Ontario. He stated that the drags are made of logs from 5 to 8 ft. long, split in half; that the halves are placed parallel to one another, edges down, flat face to the front, and firmly braced together by means of three cross-bars wedged into the holes bored through the log. A chain-hitch is attached so as to incline the drag at any desired angle, say 45°, the forward corner being at the outer edge of the road.

Such a drag Mr. McLean believes to be superior to a single-blade road scraper with a tongue rigidly attached, since the drag can be handled by one team and driver, and the scraper requires double this equipment.

On the subject of the relative place in road work of the drag and the road machine, Mr. McLean may be quoted as follows:

Much can be said that is favorable to the split-log drag; yet, as with the grading machine and other road-making implements, there is danger of overestimating its usefulness, and thereby depreciating its true worth. The grading machine is a splendid implement, but it is not too much to say that miles of road have been ruined by its improper use. In the same way, the split-log drag may be abused, and much injury to gravel or stone roads may result, if used without a thorough understanding of the treatment of such roads. The drag can be used to some extent on gravel or stone roads in the ordinary way, if care is taken not to draw soft material to the top of the gravel or stone. Its chief usefulness on these roads may be found to lie in reversing the process, and employing it to scrape off from the graveled or stone roadbeds the surface coating of fine material which collects there, and which in spring and fall becomes a blanket of mud. This blanket of mud absorbs and holds water, keeps the underlying roadbed wet and yielding, and tends to the formation of ruts.

A summary of recommendations based on points brought out by the competition is given by Mr. McLean and may be quoted here as follows:

Use a light drag—preferably of cedar, pine or basswood—such as can be readily managed by one team of horses, and use it often. Fasten a strip of steel along the lower face edge of the drag. A straightened wagon tire or sleigh runner is ordinarily used.

Use the drag as early in the spring as possible, and as frequently thereafter as is needed to keep the road smooth and free from wheel tracks.

Use the drag when the road is very wet and slushy, either when raining or immediately after; or use the drag when the road has become somewhat dry, and the soil loose and friable. There is an intermediate stage in which the earth is sticky and rolls up in lumps, instead of spreading out smoothly.

If a clay road is dragged in the wet stage, a tough, rubber-like surface is produced, but the road is very apt to be cut up by traffic before it becomes dry.

Use the drag so frequently that the road is never really out of repair, and draw only a little earth to the center at each operation. If the road is dragged only when very rough and flat, so that a great ridge of earth is piled at the center, the best results are not reached.

Give the road a round contour—not two flat planes meeting at a sharp angle in the center of the road. In doing this, a short, light drag is most serviceable.

Attach the end of the chain at the outer side of the drag to the cross-bar; and the end at the center, to a ring in front, or pass through a hole in the front of the drag. If both ends of the chain are fastened to the cross-bars, there is a downward bearing on the front of the drag liable to upset it in a manner dangerous to the operator.

The cross-bars should be nearer the top than the bottom, to allow the earth to pass underneath them.

In certain sticky conditions of the road, the drag can be reversed, drawing the round face forward.

Place a couple of planks over the cross-bars, for the operator to stand on. The operator can then regulate the work of the drag by moving from one end to the other.

The operator should have a shovel with him to trim the drains, and edges of the road; or a crowbar to pry out boulders, logs and stones. He can use these when the horses are resting.

To straighten the road, or deepen the drains, or cut down high shoulders, plow the sides, and cut up the loosened earth with a disk harrow. It can then be drawn in gradually with the drag. Turn over only one or two furrows at a time, and drag in a little at each operation.

By means of the drag, together with the plow and harrow, much can be done to grade a new road, particularly if the land is moderately level, and the soil not a heavy clay. But this work is apt to be extravagant of labor, and should be done with a grading machine.

The nature of the soil, varying from a stiff clay to a light sand, influences the use of the drag. Study the results produced by the drag under all conditions of soil, season and moisture.

Skill, born of careful observation and practice, is needed. Do not expect the best results at first.

A METHOD OF FINISHING CONCRETE SURFACES has recently been employed and patented by Mr. William D. Ham, of Knoxville, Tenn., by which a pebble dash or tiled facing can readily be given to any concrete wall with rather more hope of future stability than in the usual method of application of such finishes. In this system a thin iron plate is introduced into the wall forms just next to their outside face. To the inside face of the iron plate, tile in the desired shape and configuration, pebbles or any other similar aggregate is pasted by a strong paste, soluble in water. The concrete is then introduced into the forms as in ordinary construction, and when it has set, water is forced through a number of very small holes in the iron plate until it loosens the paste and the forms are then removed, leaving the tile, pebble or other aggregate displayed on the face of the wall and in complete union with the concrete of the mass. An improvement of the system uses the sheet-iron plates alone for the forms with supporting studs of wood and cross-braces of iron bars struts and wire ties. It is claimed that the small perforations noted serve to allow air bubbles to escape in laying the concrete, but are not of sufficient size to allow the cement to leak out of the concrete.

A STEAM SHOVEL ATTACHMENT FOR TRACTION ENGINES.

A traction engine with a steam-shovel attachment was illustrated and described in a recent issue of Engineering News, and the accompanying cut represents a similar but somewhat lighter machine for the same purpose. The attachment in this case consists of a steel A-frame mounted on the boiler, and carrying a chain attached to the bail of a wide and shallow shovel resembling a scraper bucket. The sides of the shovel are pivoted in a fork attached to the end of a lever or arm whose inner end has a bearing in a socket on the engine frame. The cut is made by the forward movement of the engine, as shown in Fig. 1. The machine is intended particularly for light work, such as long shallow cuts and long stretches of shallow irrigation or drainage ditches. Where the material has to be plowed, and is too hard for teams, the plow can be handled by the traction engine.

The attachment is secured by clamps, and no bolts or studs are put into the boiler. It can be taken off in a few minutes. A steam cylinder is a part of the attachment and does the hoisting by direct action. The shovel will swing to a right angle with the boiler, so that it can be dumped at any position within 180°. This cranning is done by a worm gear driven by chains from a clutch connection to the crank shaft of the engine. The shovel is made of boiler steel, with a renewable cutting edge. When the shovel is full, it is hoisted in horizontal position high enough to allow a wagon to drive under it, and then the load is dumped into the wagon by releasing a trip which is controlled by a cord within reach of the engineman. This position is shown in Fig. 2.

It is stated that 600 loads have been handled in a day of 10 hours on a 900-ft. haul, where 12 wagons were kept busy. The shovel has been tested in various kinds of work. In basements for buildings it has done the work of 25 hands, and it has been used in several contracts where no shovel hands, or drag scrapers or wheeled scrapers, were employed. A 10-ton engine of 15 to 18-HP. can handle a 1¼-yd. shovel, giving a full cubic yard (cut measurement) for each wagon load. The largest size is a 1½-yd. shovel, which requires a 20-HP. engine. As to rapidity of work, it is said that 100 loads per hour can be delivered into wagons under favorable conditions; where the material is dumped on the ground, two loads per minute have been handled. In ordinary work the engineman is the only man required to handle the machine, but where the machine is to be worked at its full capacity, a fireman or unskilled helper may be required.

This shovel attachment for traction engines is the invention of Mr. C. Harlan Wolfe, of Charlotte, N. C., to whom we are indebted for photographs and information. It is being manufactured by the Moffatt Machinery Mfg. Co., of the same city.

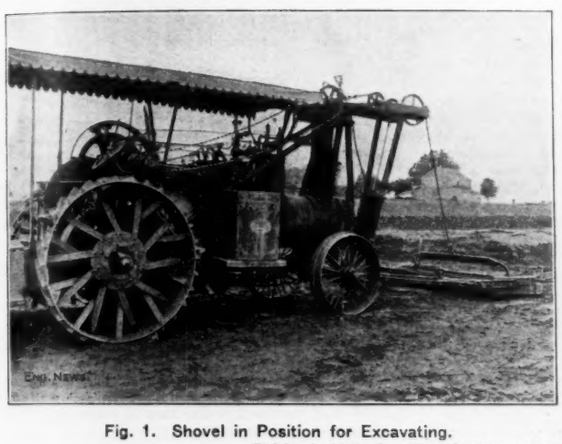


Fig. 1. Shovel in Position for Excavating.

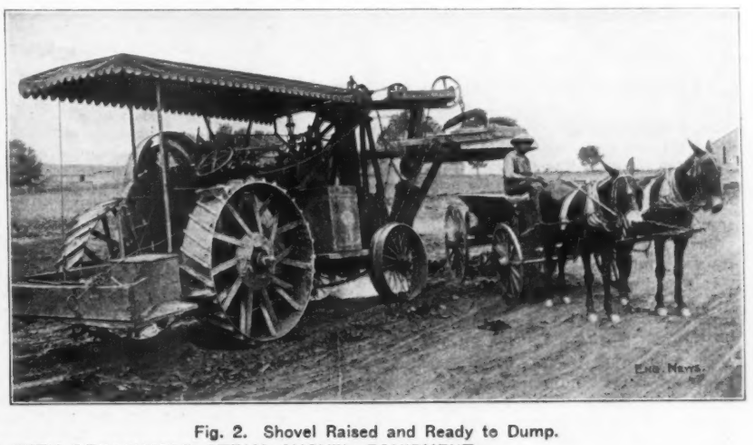


Fig. 2. Shovel Raised and Ready to Dump.

FIGS. 1 AND 2. TRACTION ENGINE WITH DETACHABLE STEAM SHOVEL EQUIPMENT.
(C. Harlan Wolfe, Inventor; Charlotte, N. C. Moffat Machinery Mfg. Co., Builders; Charlotte, N. C.)

THE DETERIORATION OF COAL IN STORAGE AND UNDER LABORATORY CONDITIONS.

The weathering of coal is a subject of abiding interest on account of the necessity of carrying a reserve of fuel at certain seasons for most large industries. The practice of open-air storage makes it desirable to know the behavior of coals when so exposed. The results of studies of this problem by Mr. S. W. Parr, Professor of Applied Chemistry, and Mr. N. D. Hamilton, Fellow in Chemistry, University of Illinois, are published in Bulletin No. 17 of the Engineering Experiment Station of the University of Illinois. Without discussing the experimental work shown by this bulletin, the summary of the results obtained may be stated as follows:

(a) Submerged coal does not lose appreciably in heat value.

(b) Outdoor exposure results in a loss of heating value varying from 2% to 10%.

(c) Dry storage has no advantage over storage in the open except with high sulphur coals, where the disintegrating effect of sulphur in the process of oxidation facilitates the escape of hydrocarbons or the oxidation of the same.

(d) In most cases the losses in storage appear to be practically complete at the end of five months. From the seventh to the ninth month, the loss is inappreciable.

(e) The rapidity or extent of this deterioration varies with different coals, but is probably most active during the first two or three weeks from the taking of the samples, but does not seem to reach a normal state till after a few months have elapsed.

The general average quantitative results of these tests are given in the following tabular arrangement:

Illinois State Geological Survey—Eight old in comparison with eight new samples	Average 2.85% lower.
Illinois State Geological Survey—Nine old samples in comparison with nine results by U. S. G. S.	Average 2.40% lower.
Illinois State Geological Survey—Twelve fresh samples in comparison with results by U. S. G. S.	Average 0.20% higher.

(e) The results obtained in small samples are to be considered as an index of the changes affecting large masses in kind rather than in degree, but since the losses here shown are not beyond what seems to conform in a general way to the experience of users of coal from large storage heaps, it may not be without value as an indication of weathering effects in actual practice.

The second part of this bulletin describes an investigation by Professor S. W. Parr and Mr. W. F. Wheeler, Assistant Chemist, Illinois State Geological Survey. This investigation was instituted to find an explanation for repeated and persistent differences in the work of the United States and the Illinois State Geological Surveys on the determination of heating values of Illinois coals. Briefly, it may be said that 50 samples of Illinois coals were placed without air drying in glass jars, 29 in a type known as the "Lightning" or "Putnam" jar, and 21 in the common "Mason" fruit jars. The former were found to give an absolute seal, while the latter showed only a partially air-tight condition. The conclusions, drawn from the action of those kept under perfect seal for ten months, are as follows:

(a) An exudation of combustible gases from coal occurs from the time of breaking out of the sample from the vein.

(b) An absorption of oxygen accompanies the exudation of hydrocarbons.

(c) Samples of coal in most carefully sealed containers are subject to deterioration.

(d) The process of deterioration is probably due to oxidation of hydrogen or hydrocarbons by means of the absorbed oxygen. It may also be due to a simple loss of combustible gases and the replacement of the same by non-combustible gases such as oxygen.

THE CHICAGO WATER DEPARTMENT and the city of Chicago have been the victims of long continued system of negligence and graft which is said to have aggregated a loss of over $1,000,000. Incorrect meter readings, tampering with meters, and the open theft of waterworks material have been the methods employed. The investigations were made by the new Superintendent of the Department, Mr. McCourt. One of the first discoveries was a 4-in. meter on a 6-in. pipe, and on test this meter did not record even half the amount of water passing through it. Meters, pipe fittings and tools have been sold by laborers and employees; some of the men are said to have worked as plumbers on their own account, using material which was ordered ostensibly for use by the department. Politics appears to have had a considerable share in the scandal, especially in padding the pay-rolls, but a thorough investigation is promised by the officials of the public works department and the civil service commission. A number of men have been discharged and suspended. At one plant having several meters, it was found that they had never been tested since being put in place; pitometer tests made for a period of four days since the discovery showed that 2,882,000 gallons entered the plant, while the meters recorded only 2,012,000 gallons. Many meters have been found unsealed. The commissioner of public works is reported as stating that the failure to test meters and to render proper water-tax bills has been due to negligence and division of authority. The department is to be reorganized.

A GAS-ENGINE WARSHIP is the British gunboat "Rattler," with which experiments are now being made. It is an old steamship, which has been lent to the Naval Reserve Service. The old machinery has been replaced by a Capitaine gas engine having five cylinders 20 × 24 ins., taking gas from a producer of the suction type. The engine is rated at 500 HP., and the total weight of machinery is 94 tons, as compared with 150 tons for the steam engine and boilers. For going astern, there is a hydraulic clutch working through an epicyclic train of wheels which reverses the rotation of the shaft, while the engine runs always in one direction. For stopping, the clutch is relieved of the hydraulic pressure, and the engine is so governed that it continues to run without load at practically the same speed as when under load. Besides the saving in weight and space of machinery, there is a large saving in labor, and the coal consumption is said to be reduced 50%. According to figures given in the "Engineer," of London, the average speed was 10½ knots, and the average cost (with coal at about $3.75 per ton) was 6.46 cts. per mile. This is said to be the first British sea-going vessel to be driven by gas power.

DIAGRAMS FOR COMPUTING THICKNESS OF STEEL PIPE SHELLS FOR DIFFERENT JOINT EFFICIENCIES.

By RICHARD MULLER,* E. E.

The task of determining the thickness of steel pipe shells for any individual case under specified conditions is relatively easy, but when the engineer has to make careful investigations and design his pipes most economically with regard to hydrostatic pressure, the work becomes tedious, and demands much time for computing and checking. The value of the accompanying diagrams, which give immediately the thickness of shells for most cases encountered in practice, will, no doubt, be recognized by all hydraulic engineers and those on whom devolve the task of designing either ordinary riveted steel pipes, surge tanks for hydro-electric plants, or tanks for water storage.

Fig. 1 has been developed so as to cover most cases liable to present themselves in water-power developments, under heads as high as 1,600 ft. Fig. 2 is particularly intended to be useful to designers of water towers, and with its help they will be able to determine the requirements for most any case to be met with. The diagrams are based on the following assumptions:

Tensile strength of plate, 50,000 lbs. per sq. in. of section.
Factor of safety, 4.
Percentage efficiency of riveted joints.†
- Single-riveted joint, 56.
- Double-riveted joint, 69.
- Triple-riveted joint, 75.
- Double-weld butt joint, 87.
- Quadruple-riveted joint, 95.

To find the thickness of shell of a steel riveted pipe for head and diameter within the limit of the diagrams, join the origin O with given head on AB and follow this line until it intersects the vertical line passing through the given diameter. At this point draw a parallel to OA, meeting AB, join again this point of intersection with the origin O, continue to assumed efficiency line. At this point a parallel to OA shows required thickness on scale.

If the problem is reversed, that is, to find safe head for a case in which diameter of pipe, thickness of shell and efficiency of riveted joint are given: through given thickness on scale draw a parallel to OA, meeting efficiency line, join the point of intersection with origin O. Where this line cuts the AB axis, draw again a parallel to OA until this meets a perpendicular line through the given diameter. Join this intersection with the origin O and continue until it meets the AB axis, where allowable head is found.

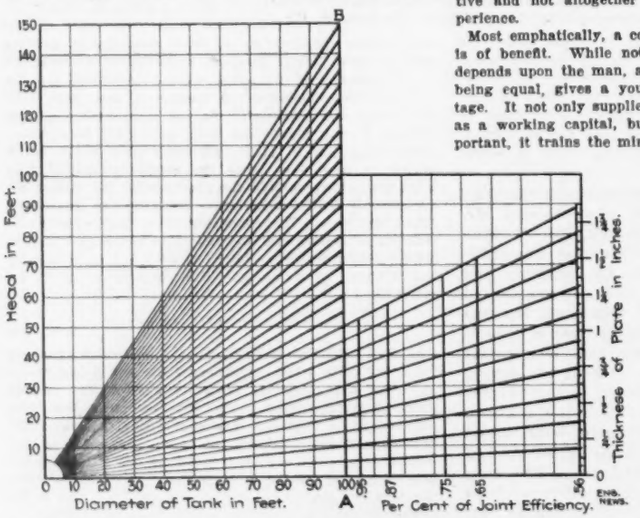


FIG. 2. DIAGRAM FOR THICKNESSES OF TANK PLATES FOR DIFFERENT JOINT EFFICIENCIES.

The dotted lines in Fig. 1 illustrate a case where, being given a head of 415 ft., diameter of pipe 6 ft., efficiency of riveted joint 87%, the thickness of shell is found to be $\frac{5}{16}$-in.

WHY SHOULD THE PROFESSION OF CIVIL ENGINEERING APPEAL TO A COLLEGE MAN?

Some students at Yale University recently addressed the question quoted above to Mr. John F. Stevens, M. Am. Soc. C. E., Vice-President of the New York, New Haven & Hartford R. R. We have been favored with a copy of Mr. Stevens' reply to the question and print it below:

There are many definitions of the term "Civil Engineering." Comprehensively it is the art of so directing the forces of nature and of so using and conserving all the material resources of the world as to advance mankind in civilization, and consequently to add to its comfort, happiness and prosperity.

The satisfaction to be derived from a successful lifetime of such work is obvious. To no one, more than to the civil engineer, is confided the trust of "making two blades of grass grow where one grew before." There is hardly an interest or a person in the world who, directly or indirectly, is not benefited by his success in his field of labor. At one time he may be introducing new and improved methods of urban transportation, he may be pushing lines of communication into the trackless desert, bringing savage tribes into close and direct contact with civilization. He may be perfecting ways of navigating the air or he may be storing up and directing water, the life blood of the world, so as to make the waste places of the earth fertile and fit for the homes of thousands.

Nearly every other branch of scientific work is largely specialized along narrow lines, but civil engineering is all-embracing and covers more interests in the world's work than any other kindred occupation, excepting possibly financiering and even this depends largely on civil engineering for its success.

And so large opportunities and greater recompenses naturally follow—recompenses not necessarily from a pecuniary point of view, but from the larger, higher, and more satisfactory point, of being able to look back from the last height, across the vale of years, and to see the monuments indicating the higher and higher marks of human accomplishment.

A man to be a successful civil engineer, in its larger meaning, must be conscientious, patient, bold, absolutely honest, and above all, he must possess strong perceptive faculties, heavily tinged with imagination. He must naturally have genius, as genius is defined, "an infinite capacity for details."

He must, as well, have the power, granted to so few, of being able to segregate such details, and to mass into a concrete whole all that is of value of what affects each particular problem. Such a power is largely intuitive and not altogether the result of education or experience.

Most emphatically, a college course in civil engineering is of benefit. While not absolutely necessary, as much depends upon the man, a scientific training, other things being equal, gives a young man an incalculable advantage. It not only supplies a fund of technical knowledge as a working capital, but what is better and more important, it trains the mind to exact methods and reduces the necessity of uncertain calculations to a minimum. It also acquaints him with the best and most valuable literature of his profession, and thus opens to him avenues of information that otherwise he might never enjoy. While an academic course will be better than none, a special engineering course is of far greater value.

Taking the past 30 years as a whole, there has always been a demand for high grade civil engineers, and the profession is not more crowded than others, probably less so. The increase in the world's population necessitates the opening of new countries, and the utmost development of the old ones. There are yet vast areas of the world which must be subjugated physically and made fit for the highest civilization; and here is where the work of the civil engineer is preeminent. The chances for success in reaching the higher levels are growing better and better, as every year the importance and dignity of the profession become more fully recognized.

The choice of what particular branch of civil engineering a man should follow, is a question which individual inclination and circumstances will largely govern. With the completion of a technical course, a young man will be theoretically equipped for any particular service; and he should accept work at whatever opening offers in the profession, until he has had time to acquire that practical knowledge of men and business which no college, however good, can give him. Two or three years, if he is receptive, will teach him human nature and enable him, like Kipling's ship, to "find himself." Opportunity will knock at his door, and he should be wise enough by that time to seize it.

No set rules can be laid down that will insure success. Like learning, "there is no royal road." Your profession must be your object, and all else, for years, be subordinate. Good habits, of course, are a necessity, close attention, to details and work, work all the time. And never stultify yourself by advancing an opinion, or by making a report, that is decided by anything excepting your very best judgment, regardless of whether you think it will be pleasing to others or not.

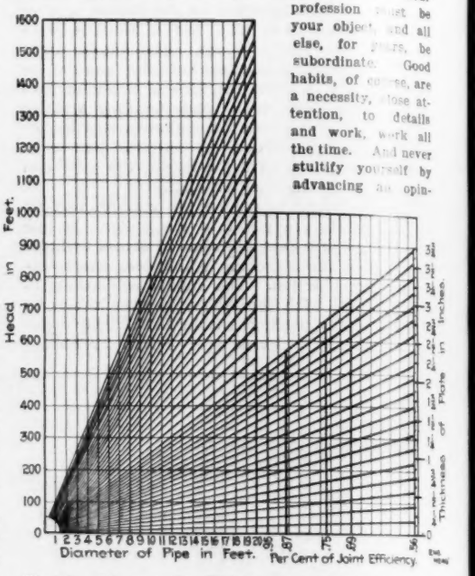


Fig. 1. Diagram for Thicknesses of Riveted Steel Pipes of Different Joint Efficiencies.

Treat your subordinates with kindness and justice, and your superiors in rank with respect, and never cheapen yourself, or your services, for the sake of a temporary advantage. Do your very best, but if the pace is too swift, drop back and score again. Time and patience, combined with incessant work, form a combination that in the long run cannot be beaten.

AN INVESTIGATION OF MUNICIPAL SUBWAYS for electrical wires is recommended by Mr. Harry P. Nichols, Engineer-in-Charge of the Division of Franchises of the Board of Estimate and Apportionment, New York City. This recommendation was brought about by the application of the Municipal Subway Co. for a franchise. Mr. Nichols in his report reviews the peculiar conditions existing in New York as regards subways for wires, owing to an uncertainty as to the relative rights of the city and several companies that now control and operate such subways. Until these questions are cleared up and the city has decided upon a future subway policy, it seems best to deny the application. In his report Mr. Nichols refers as follows to wire subways in a number of other cities:

Of the cities which have constructed conduit systems in which space is leased to wire-using companies, Baltimore is the largest of which I have any knowledge. That city began construction in 1898, and has now a system consisting of over 7,000,000 duct feet, of which about 1,750,000 duct feet are leased to public service companies, which seem well satisfied with the system. The rental varies from 5 to 7 cts. per duct foot per annum, depending upon the extent of occupancy by the company. The actual rental received for the most part is between 5 and 6 cts. per duct foot per annum. The revenue derived for the year ending Dec. 31, 1907, was $98,371, which was about 1.66 times the interest charges upon the money required for the construction of the system. The operating expense was about $8,500, showing that the system is operated at a profit. Besides this, the city uses about 50,000 duct feet for its own wires without cost to the city.

Erie, Pa., and Auburn, N. Y., each has a municipal conduit system for rental to public service corporations. Auburn has about 260,000 duct feet, of which about 88,000 ft. are rented at 5 cts. per ft. per annum. The revenue received is equal to about twice the interest on the cost of construction.

Erie had in 1905 about 200,000 duct feet; 50,000 ft. being rented at 5 cts. per ft. per annum, and the revenue derived therefrom was equal to at least twice the interest charges upon money invested.

I am informed that it is proposed to install a municipal conduit system in Hartford, Conn. The matter is now being considered. Other cities, I understand, have installed subway systems which are being operated with success.

*With Vielé, Blackwell & Buck, Consulting Engineers, 49 Wall St., New York City.

†From a discussion on the theory and practice of riveting, contained in an address delivered to students of Cornell College by Mr. J. M. Allen, Pres. Hartford Steam Boiler & Insurance Co.

A DRAW-BRIDGE WRECK, AND TEMPORARY CONSTRUCTION TO RESTORE TRAFFIC.

By MASON R' STRONG,* M. Am. Soc. C. E.

A drawbridge on the Cleveland-Cincinnati line of the Erie R. R. across the Cuyahoga River at Cleveland, Ohio, was wrecked on Oct. 21, 1907, under unusual circumstances. The photograph Fig. 1 herewith shows the result of the accident.

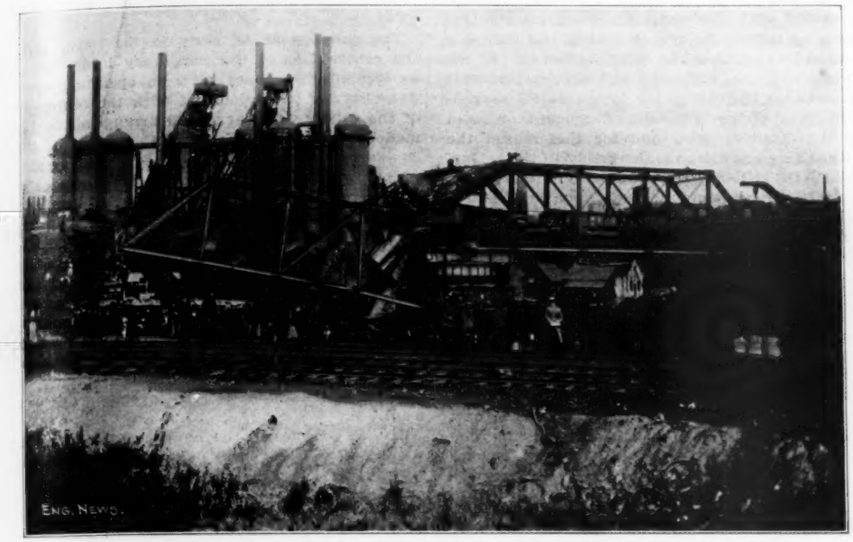


FIG. 1. WRECK OF ERIE R. R. DRAW-SPAN OVER CUYAHOGA RIVER AT CLEVELAND, O., OCT. 21, 1907.

One arm of the bridge collapsed completely, while the other arm was practically uninjured. There is a heavy traffic of freight vessels in the river at this crossing, and the railway traffic over the bridge is also very heavy. It was imperative, therefore, to restore both the channel and the track as rapidly as possible. This work was rendered more difficult by the fact that the navigation channel lay under the arm that was wrecked, so that the ruins of steelwork had to be cut apart and lifted out before any further work could be done. In spite of all these complicating conditions, however, the crossing was restored in remarkably short time.

The accident occurred while a west-bound light engine and an east-bound ore train were crossing the bridge, and was due to a combination of derailment, collision and buckling of the ore train by its pusher engine. The following report gives a brief statement of the accident:

> This accident occurred about 5 p. m., Oct. 21, 1907, resulting in the wreck of the west arm of the draw-span, which collapsed and allowed five cars loaded with ore to fall into the river. The east arm of the draw-span was not injured, other than at the center, where some members of the west arm were torn from their place.
>
> The wedge at the east end of the bridge was found broken, and it is assummed that as the west-bound engine entered on the bridge at the east end, it caused a tilting at the west end which derailed the east-bound train entering the bridge at the west end. This latter train was loaded with ore, and had a pusher on the rear, which continued to push after the derailment, until the collision occurred. The forward engine upon being derailed kept to the ties until it reached the center pier, where it struck the west-bound engine, and the loaded cars buckled, causing the west end of the draw-span to collapse.
>
> There is no evidence of any weakness of the draw or floor-system of the structure, and a recent inspection by the Engineer of Bridges showed the bridge in fairly good condition with no indication of weakness.

The bridge, No. 2.17 Mahoning Division, was a square-double-track through pin-connected truss drawbridge, 220 ft. long c. to c. end pins. The floor had transverse floorbeams at each panel, with four lines of plate-girder stringers, two under each track. The motive power was situated in an engine-house at the top center. The base of rail was about 35 ft. above the surface of the water in the river.

The center was carried upon a circular drum, which in the accident prevented the loss of whole bridge, as would have been the case had a pivoted center existed. The end lifts were of the ordinary wedge pattern; and the rail-joints at the ends were of the split-rail lift type resting in metal chairs.

All the foundations were of good stone masonry, the center pier being 37 ft. in diameter. They were protected by pile fenders, which as the crossing was skew gave less clear waterway than the span length would indicate. In the west, or thoroughfare, channel, the least clearance between fenders was 53 ft. 8 ins. (No part of any of the temporary replacement work gives less than 57 ft. here.)

As the west channel is the only one used by boats, the uninjured easterly arm of the draw could be left in place as a fixed span in the temporary reconstruction, or it could be replaced by a fixed trestle or the like. It was necessary to provide a movable span over the west channel, after clearing out the wrecked arm. The location of the crossing and the dimensions of the wrecked bridge are shown by Fig. 2, which will serve to explain the problem presented by the situation.

Various plans for restoring traffic were at once considered. The discussion covered the following methods, but rapidly narrowed down to one of the schemes whereby the span would be swung in a horizontal plane.

(1) The east arm of the old bridge might be counterweighted and swung around over the west channel, a trestle being built in the east channel. This would, however, require an immense amount of counterweight, with much new steelwork to carry it, and also the rebuilding of the destroyed engine-house and engine. All this would have been slow work; and, in addition, although a most careful inspection of this arm showed no defects, there was a possibility of unforeseen developments at the center when the arm was turned that might cost precious time when all other things were ready for reopening traffic. The trestle in the east channel might also cause future trouble and protests from the river interests.

(2) The new span could be a lift bridge hinged to the drum of the existing bridge, making, it was suggested, a most substantial construction. This proposition would, however, have made an entangling alliance with the old work which will have to be removed when the permanent bridge is built.

(3) The new construction could be as above, but hinged at the shore end instead of to the old bridge. The operation of such a contrivance with the facilities at hand would have been difficult; but a particular objection was the immense amount of counterweight and heavy guying to anchorages in a treacherous soil.

(4) Another scheme broached was to hang the new span from a guyed frame and swing it in a horizontal plane. This method would have accentuated the difficulty of guying, especially when the span was at right angles to the track; for the bank is high and the run of the guys due to this and other considerations would have been very poor.

(5) On the other hand, to have supported the end of the new span upon a float would have been easy, but operating such a draw would have been slow and clumsy, although speed is absolutely necessary, on account of the great traffic both in the river and over the bridge. A float for a span so high above the river would also have been very vulnerable in collisions with passing boats, and bulky as to clearances.

(6) On account of the above and other considerations, the most feasible method of construction was undoubtedly, as the result has proved, one in which the span could be swung without guys in a horizontal plane, independently of any connection to the metal work of the old draw-span. A bobtailed swing span was designed on this basis, pivoted on a turntable on the existing west abutment.

As soon as the accident was reported, the Bridge Department was called upon for a list of all plate-girder spans then being fabricated at bridge shops, or stored at bridge sites awaiting erection, or on cars in transit. A sketch plan of the existing drawbridge was also made on the standard 8 × 13-in. sheets which are used by the Bridge Department for the stress sheets of all plate-girder bridges, and this, together with the list of available spans and 8 × 13-in. plans of each (kept by the Bridge Department fastened

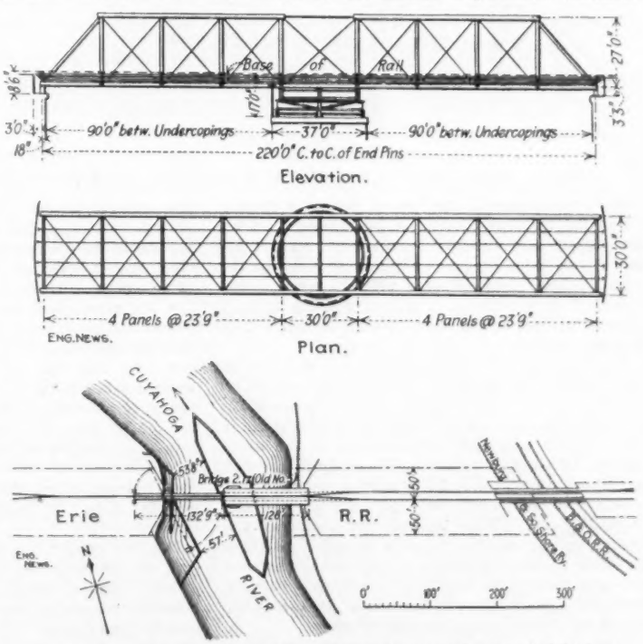


FIG. 2. PLAN OF SITE AND DIAGRAM OF OLD DRAW-SPAN, ERIE R. R. BRIDGE OVER CUYAHOGA RIVER.

togethed in a small booklet), gave really perfect data as to available material.

It was decided to use for the main span a 95-ft. deck plate-girder bridge then on cars, and for the west span a 37-ft. deck plate-girder span then stored at the Moodna Creek (N. J.) viaduct preparatory to erection in that structure. De-

*Consulting Engineer, 7 Wall St. Formerly Bridge Engineer, Erie R. R. Co.

tailed plans of these spans were at once forwarded, and by the time the large girders reached the bridge shops in Cleveland, plans of necessary changes in the girders were so far advanced that work could be commenced. Detailing developed the fact that girders deeper than the viaduct girders (which had been loaded but not yet shipped) would be desirable for the west span. New girders were therefore built from material then at the bridge shops, no delay occurring on this account. The first girders must have been replaced at the viaduct anyway, and it was better to make the west span in the more convenient manner, if only time was not lost by so doing.

SUPERSTRUCTURE. — The superstructure, therefore, consists of a heavy turntable center and a circular track, each resting upon a timber foundation. Immediately above this center is a heavy cross-girder with double webs, 54 ins. deep, and gussets to the tops of the main girders. Upon the circular track rest two balance wheels bearing upward against a built beam riveted between the webs of two gussets extending to the tops of the main girders, and also two other wheels between the main girders bearing upward against a built truck beam riveted between their bottom flanges.

The main girders thus carried and steadied at the center consist each of two beams 132 ft. 9 ins. long over all, made up of the original 95-ft. deck plate-girder span, 9 ft. 8⅝ ins. deep over angles; and of a new end section of the same depth. The center is placed 85 ft. from the end of the main girders, and the portion between this center and the shore end is here termed the "bobtail" end. This bobtail end contains the counterweight carried upon a wooden platform between the main girders. At the west abutment the span rests upon a circular track and ordinary turntable end truck wheels; while at the outer end it is carried on a sliding bearing.

Pending the installation of more elaborate wedging and locking devices, the operation was as follows: After closing the span, the bobtail end was tilted up with jacks placed upon the wooden foundations near the west or shore abutment. This brought the east or outer end down to a hard bearing on its bridge seat, and then the west end was securely wedged by hand. Regulation angle bars were then bolted in place by hand upon the track rails, so that the track was continuous and there was no danger from makeshift temporary rail-locks.

These methods of wedging the ends and locking the rails were in use but a short time, when more permanent rail-locks and wedges were installed. The wedges, two at each end and two at either side of the turntable, are driven by shafts and levers and are operated from the center with ordinary key wrenches. The rail-locks are of the sliding sleeve variety, heavy and solid, and are connected with the signaling plant so that the signaling cannot be operated until the bridge is wedged into position and the rails locked. At the bobtail end the wedging machinery is crowded out towards the end of the bridge as far as possible, thus giving a maximum amount of room for the counterweight, and for this reason the wedges here are driven transversely to the bridge.

FOUNDATIONS.—Simultaneously with the design of the superstructure, work upon the foundations was proceeding. Timber for a wooden tie floor, for grillage beams, piles and all other purposes, was roughly billed and at once shipped to the site, the bills of material being checked as the details of the plans progressed.

The conformation of the existing west pile fender was fortunately such that a new pile rest pier for the new center could be built in front of the old west abutment, but within the fender. There were thus no complications about encroachments on the stream except that when the new bridge was opened the skew of the crossing was such that the outer end would project beyond the existing fender. This trouble was overcome by constructing a new fender (see Fig. 2) extending from the point where the new span failed to clear the existing one to the new rest pier in a direction practically parallel with the fender of the old pivot pier, so that the channel is practically as good for the passage of boats as before the accident.

At the east end the new span rests partially upon a wooden bent bearing upon the solid masonry of the old pivot pier, and on the drum of the old bridge. The bent is very short and solid, but nevertheless provision has been made for shimming under the bearing plates, should any shrinkage occur whereby the span would bear unequally upon the wood and metal in combination.

The new center rest pier mentioned above has a line of planking under the course of wooden grillage beams which bears both on the pile foundation and on the wall of the existing west masonry abutment. This also provides for ready shimming in case of settlement of the piles whereby the bearing upon the masonry and the piles becomes too unequal (Fig. 3).

The westerly or bobtail end bears upon a new pile abutment at a depth of about 12 ft. below the base of rail.

OPERATION.—The new span being a deck span, it was necessary in order to permit it to swing that the embankment as well as the top of the masonry abutment be cut away.

At the same time piles were driven for a fender to define the channel, and piles for the two rest piers, and the necessary excavation was made to allow the shore arm to swing, part of the west abutment being torn down to provide clearance. All false-work was completed on Nov. 6, ready to receive the two sets of girders.

The girders were unloaded at a point as near the west abutment as possible, and after being assembled were erected. Seventy tons of pig iron were used as counterweights, evenly distributed in the last three panels of the shore arm of the bridge. The tracks at the west end were changed to provide for a single track over the combined old and new structure. The new span rests on a frame bent built on the top of the west side of the center pier. The new swing bridge was operated temporarily by a hoisting engine, using proper cables for opening and closing. This is a temporary device, it being the intention later on to place a motor attachment on the turntable. For temporary use ordinary angle bars were used to connect rails and joint ends of swing bridge, but a wedge and rail-lock arrangement has been installed satisfactorily; also interlocking, to conform with the laws in such construction.

The bridge was put in service for regular traffic at 8 p. m., Nov. 7. Thus the actual time of interruption to traffic was 17 days. The first four days of this time were consumed in preliminary arrangements and clearing wreckage, so that the

Preparations were made for installing a gasoline motor working on a rack circle at the bobtail end; but, as a temporary expedient, a hoisting engine was used to swing the bridge operating a line to a sheave upon the outer rest pier of the bobtail end and returning again to the engine drum. The cable was thus continuous, and being attached at one point to a main girder, easily moved the span. The action of this device was so satisfactory that the motor was not substituted.

The question arose, early in the work, where the center line of the temporary bridge should be located. As there were no operating objections, it was put coincident with the center line of the existing east arm, and arrangements were made to run the track down the center of that double-track span. This loads the trusses equally, which is a desirable thing, for then there exists no diagonal uplifting tendency in the drum, due to reactions unequal in the two trusses.

PROGRESS OF REPLACEMENT WORK.—The various details of the work in the office, assembling materials, field construction, and shop fabrication, all proceeded simultaneously and so smoothly that there was no delay occasioned by one class of work waiting upon another, as the prompt time of completion for so considerable an undertaking indicates. The result is giving exceeding satisfaction to the operating department.

Driving of piles in the new turntable pier was started on Oct. 25, three days after the accident.

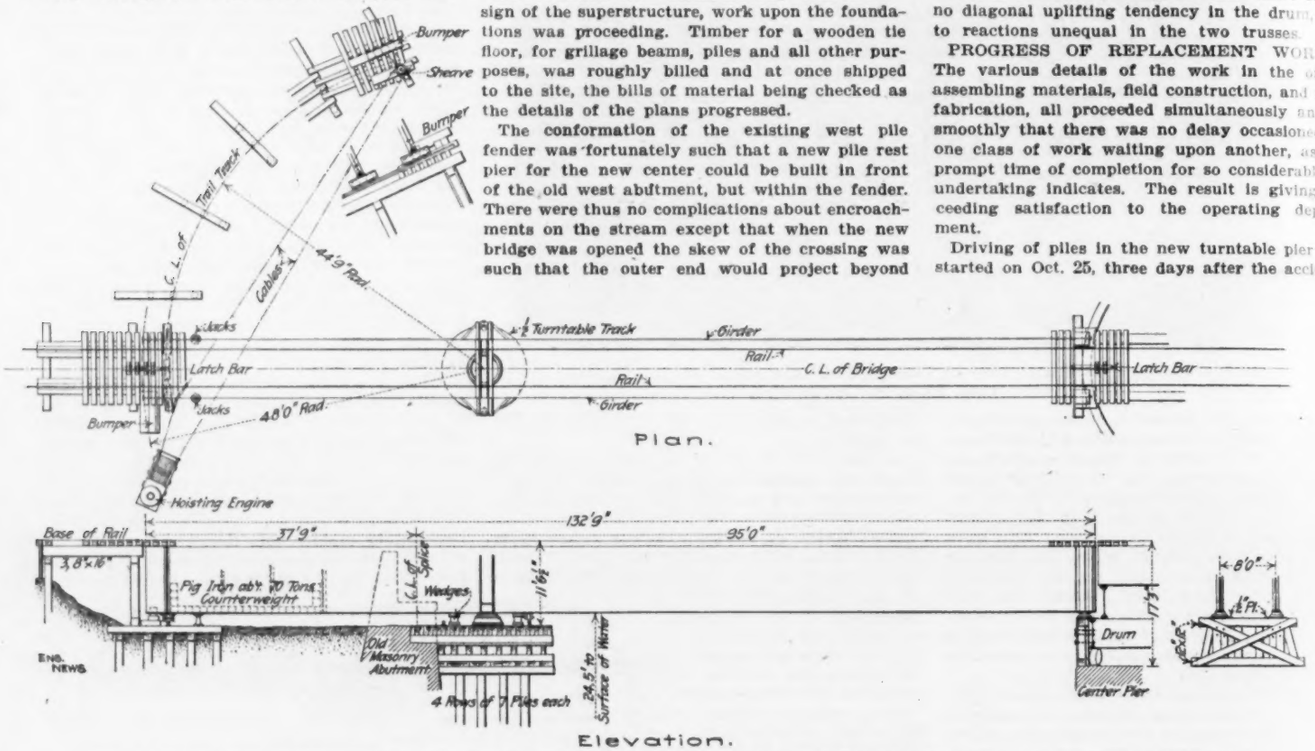


FIG. 3. PLAN AND ELEVATION OF BOB-TAILED TEMPORARY SWING-SPAN OVER WEST CHANNEL OF WRECKED CROSSING.

actual time occupied in providing the new structure was 13 days.

The plans for the permanent reconstruction now under way contemplate a rolling lift drawbridge of a single span.

The work described was done under the general direction of Mr. Francis L. Stuart, Chief Engineer, by the regular organization of the Bridge Department, Mr. F. L. Howard, Engineer of Bridges, and Mr. H. H. Althouse, Assistant Engineer, at Cleveland. The writer, as Consulting Engineer to the Department, was closely connected with the design of the temporary work. The construction and erection of the temporary draw was done by the King Bridge Co., of Cleveland, Ohio.

THE USE OF CYPRESS FOR TIGHT COOPERAGE.*

Cypress-wood for tight cooperage may find a greatly increased use as a result of the recent award of a prize by the California Wine Growers' Association to the Southern Cypress Manufacturers' Association in a competition for the best substitute for white oak wine barrels. The competition was held under the auspices of the National Irrigation Congress, which met at Sacramento, Cal., in September, 1907, and a committee appointed by that congress made the award after several months' deliberation and investigation.

Previous to the competition and in preparation for it, the Southern Cypress Manufacturers' Association made a series of experiments and tests under the direction of Dr. Hermann Von Schrenk, Pathologist, Bureau of Plant Industry, United States Department of Agriculture, Missouri Botanical Gardens, St. Louis, Mo. It was desired to ascertain whether or not the qualifications of cypress, in the following ways, were satisfactory for making wine barrels. (1) It should be strong enough to withstand considerable punishment in shipping. (2) It should impart neither color nor taste to the liquid contained. (3) It should not have sufficient porosity so that excessive leakage loss could occur. (4) It should hold its shape so that frequent re-cooperage should not be necessary. (5) The price of the wood should be such that cypress barrels could be made as cheap or cheaper than white oak.

In making demonstrations of the strength of cypress barrels a number were made up in Kentucky and shipped to the Irrigation Congress in California.

In making a comparison of woods, as to their qualities of imparting color and taste to liquids held in contact with them, a series of elaborate experiments were carried out. Many samples of wood, notably redwood, California, Idaho and Washington cedar, and western spruce, were soaked for three or four weeks in an artificial wine composed of water, 90 liters; 95% alcohol, 10 liters; tartaric acid, 400 grams; glacial acetic acid, 100 c. c. All samples of cypress tested gave no taste or color to this liquid, while all of the other woods gave one or both of the undesirable results.

In examining the cypress for density it was found that some pieces absorbed considerable quantities of the wine solution, but it was found that the amounts varied through a range similar to that found for various samples of white oak. Two barrels were given a trial in the storage rooms of a large California winery. One barrel was steamed and filled with a white dry wine, while the other was filled without steaming. fter 62 days the former had lost about 0.72% of its weight of liquor and the latter 0.47%. They had absorbed at the end of this time 1.4% and 1.9%, respectively, of their liquid contents.

While these studies and results related particularly to tight cooperage for wine storage, it is claimed as a result that it has been demonstrated that cypress is strong enough, dense enough and inert enough for general vat, tank and barrel uses, especially where alcoholic or food preparations are to be held.

*From information furnished by the Southern Cypress Association, G. E. Watson, Secretary, Hibernia Bank Bldg., New Orleans, La.

PROPOSED NATIONAL PUBLIC HEALTH, WATER SUPPLY AND SEWERAGE INVESTIGATIONS.

An important bill in the interests of the public health of the whole country was introduced in the House of Representatives on March 6 by Mr. W. P. Hepburn, of Iowa. The bill enlarges the powers and duties of the U. S. Public Health and Marine-Hospital Service by authorizing it to make special investigations of tuberculosis, typhoid fever and other diseases, and of water supply and sewage disposal with particular reference to stream pollution. The bill also provides for the establishment of a school of hygiene open to State, county and municipal health officers. In addition, provision is made for increasing the number of conferences now held between the U. S. Public Health and Marine-Hospital Service and the health authorities of the several States, and also for increasing the compensation and duties of the advisory board which has recently been assisting the Public Health and Marine-Hospital Service in its Washington typhoid investigations.

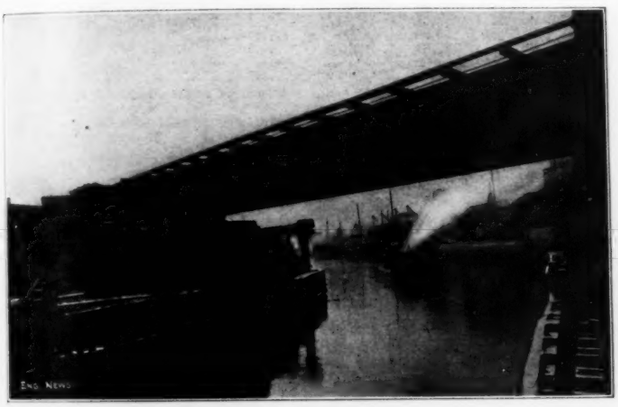


Fig. 4.

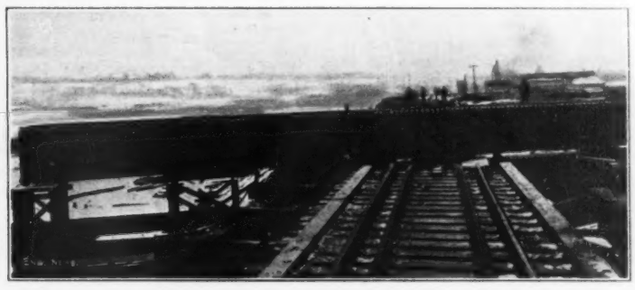


Fig. 5.

FIGS. 4 AND 5. TEMPORARY DRAW, CLOSED AND OPEN.

The bill is so important and at the same time so brief that we reprint it in full, as follows:

A BILL TO FURTHER PROTECT THE PUBLIC HEALTH AND IMPOSING ADDITIONAL DUTIES UPON THE PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

Be it enacted, etc., That, in addition to the laboratory investigations now authorized by law of infectious and contagious diseases, the Surgeon-General of the Public Health and Marine-Hospital Service, with the approval of the Secretary of the Treasury, shall from time to time make special investigations into the prevalence of tuberculosis, typhoid fever, rabies, and other diseases affecting man, the conditions influencing their propagation and spread, and methods necessary for their prevention and suppression. These investigations shall include housing, occupation, and disposal of wastes, as they affect the public health. The investigation of rabies shall include the preparation and use of the virus or other substance made in the hygienic laboratory for its prevention in those exposed. He is further authorized, on request of the health authorities of a State, Territory, or the District of Columbia to detail officers to cooperate with said authorities in their measures for the protection of the public health.

Sec. 2. That the results of the investigations authorized in Sec. 1 of this Act shall be published in the discretion of the Secretary of the Treasury, and there shall also be disseminated by means of sanitary bulletins and exhibits practical information concerning the prevention or suppression of tuberculosis, typhoid fever, and other diseases pertaining to man, and the Surgeon-General shall prepare and distribute said bulletins. He shall also cooperate with the trustees of the U. S. Pharmacopeia and prepare and publish, with the approval of the Secretary of the Treasury, digests embodying the results of investigations for use in revision of said pharmacopeia.

Sec. 3. That to facilitate cooperation between State and Territorial boards of health or departments of health, including the District of Columbia, and the Public Health and Marine-Hospital Service, there shall be established a school of hygiene for which the facilities of the hygienic laboratory shall be available. Regulations for admission to and for the conduct of said school shall be made by the Surgeon-General with the approval of the Secretary of the Treasury. There shall be received in this school, with such limitations as may be deemed necessary, State, county, and municipal health officials, on application by the board of health or health department of any State, Territory or the District of Columbia: Provided, That satisfactory assurance is given with the application and by the health officer himself that the special instruction desired is to be utilized in the performance of official health duties. Officers of the Public Health and Marine-Hospital Service shall be detailed as instructors in said school, and officers of said Service may also be detailed to receive instruction. An official, upon satisfactory completion of the course of study in sanitary science as prescribed in the regulations, shall be entitled to a certificate to that effect.

Sec. 4. That the bureau division of domestic quarantine and the bureau division of foreign and insular quarantine are hereby consolidated into one division, to be known as the division of quarantine, and there is hereby established a bureau division of water supplies and sewerage. Each of these divisions shall be in charge of a commissioned medical officer of the Service detailed and designated for that purpose, who, while thus serving, shall be an assistant surgeon-general, as now provided by law for the medical officers in charge of the remaining divisions of the bureau; and it shall be the duty of the Surgeon-General, under direction of the Secretary of the Treasury, to investigate the pollution of interstate waters as it affects the public health and make report upon the methods necessary to prevent said pollution, with recommendation as to necessary legislation relating thereto. For this and other purposes there shall be appointed by the Secretary of the Treasury, on recommendation of the Surgeon-General, a sanitary engineer competent to solve technical problems connected with the purification of water and sewage, the salary of said engineer to be fixed by the Surgeon-General, with the approval of the Secretary of the Treasury, and not to exceed $5,000 per annum. There shall also be appointed in like manner a solicitor of the Public Health and Marine-Hospital Service, who shall be familiar with the public health laws of the National Government, States, and municipalities, to aid in establishing uniform measures for the protection of the public health, and to perform such service of a legal nature as may be required. The salary of the solicitor shall be fixed by the Surgeon-General, with the approval of the Secretary of the Treasury, and shall not exceed $5,000 per annum.

Sec. 5. That in addition to the conferences now authorized by law to be held between the Surgeon-General of the Public Health and Marine-Hospital Service and the health authorities of the States, Territories, and the District of Columbia, when in the opinion of the Surgeon-General it is in the interest of the public health to call a special conference, to be held in Washington, of said health authorities of not more than five States and one only from each State, the said delegates shall receive a compensation of $10 a day, including the days of travel to and from Washington and necessary traveling expenses: Provided, That not more than five such conferences shall be held in any one year and the duration of any such conference in Washington shall not exceed three days. The five members of the advisory board of the hygienic laboratory now entitled by law to receive compensation when called in conference shall hereafter receive a compensation of $20 a day, including the days of travel to and from Washington by the shortest practicable route, together with necessary traveling expenses: Provided, That the said advisory board, in addition to its duties as now defined by law, shall, while in conference, consult and advise with the Surgeon-General with respect to scientific matters relating to the public health.

It is of interest to note that many years ago the United States had a National Board of Health. We reprint below a brief outline of its history from the introductory portion of the monthly catalog of the U. S. Superintendent of Documents for November, 1907.

As it is a current prediction that a bill for the creation of a national board of health will be introduced at the first session of the 60th Congress, it may be of present interest to recall how the former National Board of Health was made to die a lingering death by slow starvation. The Board was created by an act approved

March 3, 1879 (45th Cong., 3d sess., chap. 202), providing for the appointment by the President of seven members and the detail of one member each from the Army, the Navy, the Marine-Hospital Service, and the Justice Department. The duties assigned to it were to obtain information as to all matters affecting the public health, to advise the departments of the general Government and the Executives of the States on such matters, and to report a plan for a national public health organization. The act also requested and directed the National Academy of Sciences to cooperate with the Board.

The new Board was organized April 2, 1879. By act of June 2, 1879 (46th Cong., 1st sess., chap. 11), an act of the preceding year which had established a national quarantine system under direction of the Marine-Hospital Service was repealed and the powers and duties which had been conferred by it were transferred to the National Board of Health, for whose work $500,000 were appropriated, but the operation of the act was limited to a period of four years. The Board published annual reports, 1879-85, seven in all. The Board also made quarterly reports to the Secretary of the Treasury, and issued a weekly bulletin in quarto form from July 5, 1879, to July 1, 1882. The final number was the first of Vol. 4. Publication was suspended at this point because the printing appropriation had given out, and it was never resumed.

The Board was composed of eminent men, but it failed to find favor with Congress and it was starved to death. For the first few years its annual appropriation was $75,000, but by act of Aug. 7, 1882, the Board was directed to confine its activities to cholera, smallpox, and yellow fever, and its support was limited to such part of an appropriation of $50,000 in aid of State and local quarantine authorities as the Secretary of the Treasury might allot to it. March 3, 1883, $10,000 was appropriated, but its expenditure was limited to the pay and personal expenses of members of the Board. March 3, 1885, there was a small appropriation for rent and employees for a term to end the same month. On the same date was granted $5,000 for pay and expenses of members. Aug. 4, 1886, a similar appropriation was made of $600. March 2, 1889, the final appropriation was voted, $1,004 for storage of books, records and furniture to March 4, 1889, and for their transportation to the Office of the Surgeon-General of the Army, "where they shall hereafter be stored." The act of June 2, 1879, conferring extensive powers upon the Board, but limiting its operation to four years, was not repealed or renewed. The Board therefore virtually expired June 2, 1883.

THE WIDENING OF THE WESTERN RY. OF France on the main line from the Paris Suburban district to the great terminal station of St. Lazare will involve difficult and costly works. On this part of the line the same tracks have at present to carry the main-line non-stopping trains and also numerous suburban trains making frequent stops. From the Asnieres viaduct over the river Seine to the St. Lazare terminal the traffic is complicated by light engines and light trains, as the passenger car yards and locomotive facilities are located near the viaduct. The line is in an open cut with masonry retaining walls, and flanked on either side by parallel streets. Two additional main tracks are to be built from the station to the suburban point where the main-line divisions diverge, and two auxiliary tracks for light engines and empty trains will be built from the station to the yards. There will then be ten tracks, eight of which will be for regular traffic, thus allowing the suburban trains to be handled independently of the main-line trains. To accomplish this, the cut will be widened on each side, the retaining walls being under the streets and carrying steel cantilever brackets by which the roadway will be supported over the tracks. In some places the cantilevered portion of the street will be 23 ft. wide.

REMOVAL OF MANGANESE from ground water at Breslau has been given a large amount of study of late. From a note on this subject by Mr. Robert Spurr Weston, Assoc. M. Am. Soc. C. E., in the "American Journal of Public Hygiene" for February, 1908, it appears that when the wells were first put in use manganese was not noticeable in the water after it had been treated for the removal of iron. Later the water contained an average of 8 parts of manganese per 1,000,000. It is expected that as a result of the studies made the procedure for the removal of both iron and manganese will be as follows: (a) Iron removal by aeration and filtration; (b) Mix defecated water with lime water; (c) aeration; (d) sedimentation; (e) filtration through sand and gravel; (f) filtration through fine sand filter and treatment with CO_2. Mr. Weston's note is based on an article by Messrs. H. Luehrig and A. Blasky, in "Chemische Zeitung," No. 31. An account of the influx of manganese into the Breslau water was published in Engineering News of Oct. 4, 1906.

THE COST OF BRICK PAVEMENTS AND CEMENT-MORTAR CURBS AT CENTERVILLE, IOWA.

By M. G. HALL.*

During the years 1905 and 1906 the writer kept labor, material and cost accounts of brick pavements and cement-concrete curbs that may be of value to those engaged in street improvement work elsewhere. The records are submitted herewith, in tabular form.

BRICK PAVEMENTS. — Purington paving brick were laid on a 5-in. concrete foundation, with a 1½-in. sand cushion between. The concrete was 1:3½:6, the latter of broken stone. The joints were filled with 1:1 cement mortar. Expansion joints of asphalt filler were placed along each curb and transversely every 50 ft.

Cement was bought by the barrel, sand by the ton and stone by the cubic yard. As a rule, the men worked 10 hours a day.

No attempt was made to keep track of the grading for this work, for, as is the case in most street grading of this kind, there was no uniformity of the surface before the grading was begun. The grade of the street was changed in many instances quite materially from the old grade.

The data for the labor costs and quantities of materials were obtained by daily inspector's reports. A blank was provided each inspector, one of which is reproduced herewith. These blanks were put up in books of 100 each and were turned in to the office every few days. Each day they were checked over and commented on by the engineer in charge, which in these cases was the writer, and if there were any irregularities they were corrected while fresh in mind. It will be noted that the blanks cover each separate division of the work, so that no matter what work the inspector was on he had a blank for that particular work, and though he might change several times during the day from one part of the work to another still there were no duplications of accounts by inspectors, as the blanks were posted each day, and their instructions were to post only that part of the work under their own supervision. We had inspectors on every part of the work at all times, so we felt that we were getting very accurate accounts.

Table I. was divided as shown in order to keep track of the work done under different conditions in different places. Thus Job No. 1 was paving done in alleys, where there were no curbs, but crowded spaces. Job No. 2 was nearly all along a street car track. No concrete was put under the ties, so the tie area is included in the concrete laid. The total width of this pavement was 30 ft.

The other jobs were done on streets where conditions were favorable.

Tables II. and III. give information of a similar nature on the cost of cement curb, which was built at the same time as this pavement.

*Superintendent of Water-Works, Centerville, Iowa.

TABLE II.—FORCE, MATERIAL AND COST ACCOUNT FOR CEMENT-MORTAR CURBS AT CENTERVILLE, IOWA, 1905.

(The curbs were 5 × 18 ins. in size, with a 6-in. cinder foundation and a 3-in. cinder backing. A 1 : 3 mixture was used, or 2 sacks of cement to 3 wheelbarrows of sand, mixed in a ½-cu. yd. Smith mixer. The contractors were the Jackson Construction Co., Cedar Rapids, Iowa.)

	1,990 lin. ft. of curb.				9,001 feet of curb.			
	Hours of labor.	Wages per hour.	Cost.	Cost per ft.	Hours of labor.	Wages per hour.	Cost.	Cost per ft.
Foreman	130	$0.35	$45.50	$0.0228	432	.35	$151.20	$0.0150
Trenchmen	342	.20	68.40	.0344	1,748	.20	349.60	.0350
Form setters	156	.35	54.60	.0274	1,146	.35	401.10	.0402
Filling cinders	47	.20	9.40	.0047	300	.20	60.00	.0062
Wheelers	58	.20	11.60	.0058	332	.20	66.40	.0068
Tampers	24	.20	4.80	.0024	185	.20	37.00	.0037
Finishers	24	.35	8.40	.0042	200	.35	70.00	.0070
Men on mixer	90	.22	19.80	.0099	611	.22	134.42	.0134
Removing forms	48	.20	9.60	.0048	121	.20	24.20	.0024
Back filling	77	.20	15.40	.0078	321	.20	64.20	.0064
Team and teamsters	192	.40	76.80	.0386	925	.40	370.00	.0371
Miscellaneous	72	.20	14.40	.0072	408	.20	99.60	.0100
Water boy	65	.10	6.50	.0033	310	.10	31.00	.0031
Total	1,325		$345.20	$0.1733	7,129		$1,858.72	$0.1862
Sacks of cement	435	$0.35	$152.25	$0.0765	2,221	.35	$777.35	$0.0776
Sand (est.) 300 lb. sac. C.	.....	.70/2000 lb.	45.68	.0230	.....	.70/2000 lb.	233.20	.0234
Cinders (est.)	.....	.....	39.80	.0200	.....	.....	199.22	.0200
Hauling sand (est.)	.....	.....	22.84	.0115	.....	.....	116.60	.0117
Total costs	.....	.....	$605.67	$0.3043	.....	.....	$3,185.19	$0.3189
	1 sack cement built 4.6 ft. of curb.				1 sack of cement built 4.5 ft. of curb.			

Partial Cost of 5,306 ft. of 5" × 18" curb.
Labor is for mixing and putting concrete in place only.
1,028 sacks of cement at 35c.=$364.80, or $0.0687 per ft.

596 hrs. of labor at 20c. = $147.16, or $0.028 per ft.
1 sack of cement built 5.25 ft. of curb.

TABLE III.—FORCE, MATERIAL AND COST ACCOUNT FOR CEMENT-MORTAR CURBS AT CENTERVILLE, IOWA, 1906.

(The curbs were similar in size, etc., to those described in the note under the title of Table II. The contractors were the Davenport Construction Co.)

	19,642 lin. ft. of curb.				7,241 lin. ft. of curb.			
	Hours of labor and quantities of materials.	Wages and prices.	Cost.	Cost per ft.	Hours of labor and quantities of materials.	Wages, and prices.	Cost.	Cost per ft.
Graders	1,673	$0.20	$334.60	$0.017	628	.20	$125.60	$0.017
Setting forms	914	.27½	251.35	.013	572	.27½	157.30	.022
Foundations	464	.20	92.80	.005	78	.20	15.60	.002
Men at mixer	433	.20	86.60	.004	176	.20	35.20	.005
Sand wheelers	505	.20	101.00	.005	103	.20	20.60	.003
Foreman	633	.40	253.20	.013	220	.40	88.00	.012
Water boy	457	.10	45.70	.002	200	.10	20.00	.003
Concrete wagons	357	.35	225.95	.011	103	.35	36.05	.005
Concrete shovelers	537	.20	107.40	.005	.....	.....	.....	.....
Concrete tampers	369	.20	73.80	.004	114	.20	22.80	.003
Finishers	301	.30	90.30	.005	45	.20	13.50	.002
Others	47	.20	9.40	.0005	202	.20	40.40	.006
Removing forms	282	.20	56.40	.003	135	.20	27.00	.004
Backing up	758	.20	151.60	.008	521	.20	104.20	.014
Teams	291	.35	101.85	.005	312	.35	109.20	.015
Total labor	.....	.....	.....	.....	.....	.....	.....	.....
Sacks of cement	4,300	$0.53	$2,283.77	$0.116	1,306	$0.53	$691.18	$0.096
Cu. yds. sand (est.)	= 479	.95	455.05	.023	145	.95	137.75	.019
Hauling cement (est.)	....	4% cost	91.34	.005	....	4% cost	27.65	.004
Hauling sand (est.)	....	50% cost	227.52	.012	....	50% cost	68.88	.010
Cinders and hauling same (est.)	....	.....	196.42	.010	....	.....	72.41	.010
Total costs	....	.....	$5,236.05	$0.266	....	.....	$1,813.32	$0.257
	1 sack of cement built 4.56 ft. of curb.				1 sack of cement built 5.54 ft. of curb.			

NOTE.—Most of grading was done ahead of curb gang, hence not included in above costs. Also data in last section of work seemed to be incomplete, namely for the 7,241-ft. job.

TABLE I.—FORCE ACCOUNTS AND MATERIALS FOR BRICK PAVING LAID AT CENTERVILLE, IOWA, 1905 AND 1906.

CONCRETE FOUNDATION. (1c:3½s:6r.)

	Sand wheelers.	Stone wheelers.	Concrete wheelers.	Concrete wagons.	Machine men.	Spreaders.	Tampers.	Cement men.	Foreman.	Water boy.	Extras.	Totals.	Sacks cement.	Sand.*	Rock.†	Hauling cement.	Hauling sand.	Hauling rock.	Coal for mixer.	Water.	Totals.
No. 1—20′ Alleys, 6,013 yds.																					
Labor in hours and quantities of materials	134	347	....	149	149	153	62	12	62	....	4	1,072	1,806	326.5T	426yd.	.....	.....	.....	....	....	.....
Wages and prices	$0.20	.20	....	.40	.25	.22½	.20	.20	.30	....	.20	Av.247	.34½	.70	1.10	5%cst	50%cst	50%cst	....	....	.....
Total costs	$26.80	69.40	....	59.60	37.50	36.80	12.40	2.40	18.60	....	.80	264.30	643.77	288.55	468.60	32.19	114.27	234.30	6.00	12.00	2,363.98
Cost per sq. yd.	.....	.....	....	.....	.....	.....	.....	.....	.....	....	....	.044	.107	.048	.076	.005	.019	.038	.001	.002	.342
No. 2—30′ × 40′ Streets, 5,933′ of St. car track; in all, 26,290 yds.																					
Labor in hours and quantities of materials	648	1,684	207	498	572	881	330	221	218	218	910	6,387	7,334	1284.5T	167.6yd.	.....	.....	.....	....	....	.....
Wages and prices	$0.20	.20	.20	.40	.25	.25	.20	.20	.30	.10	.20	Av.227	.34½	.70	1.10	5%cst	50%cst	50%cst	....	....	.....
Total costs	$129.00	336.80	41.40	199.20	143.00	220.25	66.00	44.20	65.40	21.80	182.00	1,449.65	2,460.23	898.40	1,843.00	123.60	449.20	921.80	30.00	60.00	8,150.38
Cost per sq. yd.	.....	.....	....	.....	.....	.....	....	....	....	....	....	.055	.094	.034	.070	.004	.017	.035	.001	.002	.312
No. 3—15,892 sq. yds.																					
Labor in hours and quantities of materials	1,181	.....	....	506	678	564	153	....	138	157	187	.....	5,038	931.65	1,151	145	.....	.....	15T	....	.....
Wages and prices	$0.20	.....	....	.40	.25	.22½	.20	....	.30	.10	.20	.....	.47	.70	1.20	.60	50%cst	50%cst	2.50	....	.....
Total costs	$236.20	.....	....	202.40	169.50	126.90	30.60	....	41.40	15.70	37.40	623.90	2,367.86	652.16	1,391.20	87.00	326.08	695.60	37.50	31.78	6,213.00
Cost per sq. yd.	.....	.....	....	.....	.....	.....	.....	....	.....	.....	....	.039	.149	.041	.088	.005	.021	.044	.002	.002	.391
No. 4—9,900 sq. yds.																					
Labor in hours and quantities of materials	703	.....	....	341	275	323	141	12	120	141	248	.....	3,258	570	774	79	.....	.....	8T	....	.....
Wages and prices	$0.20	.....	....	.40	.22½	.22½	.20	.20	.30	.10	.20	.....	.50	.70	1.20	.60	50%cst	50%cst	2.50	....	.....
Total costs	$158.60	.....	....	136.40	61.87	72.67	28.20	2.40	36.00	14.10	49.60	401.24	1,629.00	399.00	892.80	47.40	199.50	446.40	20.00	19.80	4,055.14
Cost per sq. yd.	.....	.....	....	.....	.....	.....	....	....	....	....	....	.041	.164	.040	.090	.005	.020	.045	.002	.002	.407
No. 5—32,167 sq. yds.																					
Labor in hours and quantities of materials	2,949	.....	....	847	990	1,068	499	....	267	300	349	.....	9,747	1,706	2,227	167	.....	.....	30T	....	.....
Wages and prices	$0.20	.....	....	.40	.22½	.22½	.20	....	.30	.10	.20	.....	.53	.70	1.20	.60	50%cst	50%cst	2.50	....	.....
Total costs	$589.80	.....	....	338.80	222.75	240.30	99.80	....	80.10	30.00	69.80	1,671.35	5,165.90	1,194.20	2,672.40	100.20	597.60	1,336.20	75.00	64.33	12,877.18
Cost per sq. yd.	.....	.....	....	.....	.....	.....	....	....	....	....	....	.052	.160	.037	.083	.003	.019	.041	.002	.002	.399

*650 lbs. per sack of cement, 2,700 lbs. cu. yd.
600 lbs. per sack of cement, 2,626 lbs. cu. yd.

BRICK AND LAYING.

	Brick wheelers.	Brick layers.	Brick handlers.	Sand cushion.	Sand wheelers.	Foreman	Patchers.	Water boy.	Extras.	Totals.	Brick.	Hauling brick.	Sand for 1½-in. cushion.	Hauling sand.	Totals.
No. 1—20′ Alleys, 6,013 yds.															
Labor in hours and quantities of materials	386	260	105	325	....	98	19	77	38	1,308	339,734	.....	338.17	.....	.....
Wages and prices	$0.20	.25	.20	.25	....	.30	.20	.10	.35	Av.226	.....	.....	.70	50%cst	.....
Total costs	$77.20	65.00	21.00	81.25	....	29.40	3.80	7.70	11.80	297.15	4,599.95	210.46	236.72	118.36	5,463.14
Cost per sq. yd.	.....	.....	....	.....	....	.....	.....	....	.....	.049	.765	.035	.039	.02	.908
No. 2—30′ × 40′ Streets, 5,933′ of St. car track; in all, 26,290 yds.															
Labor in hours and quantities of materials	1,401	798	354	808	70	282	271	203	286	4,473	1,485,385	.....	1,483.82	.....	.....
Wages and prices	$0.20	.25	.20	.25	.20	.30	.20	.10	.20	Av.22	.....	.....	.70	50%cst	.....
Total costs	$280.20	199.50	70.80	202.00	14.00	84.60	54.20	20.30	57.20	982.80	20,111.85	920.15	1,038.67	519.33	23,572.80
Cost per sq. yd.	.....	.....	....	.....	....	.....	.....	....	.....	.037	.765	.035	.039	.02	.896
No. 3—15,892 sq. yds.															
Labor in hours and quantities of materials	1,080	654	....	911	....	196	.....	283	820	.....	889,952	.....	893.91	.....	.....
Wages and prices	$0.20	.22½	....	.22½	....	.25	.....	.10	.20	.....	.....	.....	.70	50%cst	.....
Total costs	$216.00	147.15	....	105.97	....	49.00	.....	28.30	165.80	712.22	12,157.38	556.22	625.74	312.82	14,364.38
Cost per sq. yd.	.....	.....	....	.....	....	.....	.....	....	.....	.045	.765	.035	.039	.02	.904
No. 4—9,900 sq. yds.															
Labor in hours and quantities of materials	671	352	....	516	....	130	.....	266	601	.....	554,400	.....	549.5	.....	.....
Wages and prices	$0.20	.22½	....	.22½	....	.30	.....	.10	.20	.....	.....	.....	.70	50%cst	.....
Total costs	$134.20	79.20	....	116.10	....	39.00	.....	26.60	120.20	515.30	7,573.50	346.50	384.65	192.32	9,012.27
Cost per sq. yd.	.....	.....	....	.....	....	.....	.....	....	.....	.052	.765	.035	.039	.020	.911
No. 5—32,167 sq. yds.															
Labor in hours and quantities of materials	2,396	1,264	....	1,788	....	436	.....	319	1,893	.....	1,701,352	.....	1,809	.....	.....
Wages and prices	$0.20	.22½	....	.22½	....	.35	.....	.10	.20	.....	.....	.....	.70	50%cst	.....
Total costs	$479.20	284.40	....	402.30	....	152.60	.....	31.90	378.60	1,631.00	25,733.60	1,125.85	1,266.30	633.15	30,389.90
Cost per sq. yd.	.....	.....	....	.....	....	.....	.....	....	.....	.051	.80	.035	.039	.02	.945

CEMENT FILLER. (1c:1s.)

	Screening.	Foreman.	(Dry) mixers.	(Wet) mixers.	Rubbers.	Wheelers.	Water boy.	Extras.	Patching.	Totals.	Sack cement.	Sand.*	Hauling cement.	Hauling sand.	Totals.
No. 1—20′ Alleys, 6,013 yds.															
Labor in hours and quantities of materials	36	13	40	32	110	35	15	18	....	299	435	21.75T	....	....	.....
Wages and prices	$0.22½	.30	.22½	.22½	.20	.20	.10	.20	....	Av.21	.34½	.70	5%cst	50%cst	.....
Total costs	$8.10	3.90	9.00	7.20	22.00	7.00	1.50	3.60	....	62.90	149.47	15.23	7.50	7.61	243.31
Cost per sq. yd.	....	....	....	....	....	....	....	....	....	.0104	.0248	.0025	.0012	.0012	.0401
No. 2—30′ × 40′ Streets, 5,933′ of St. car track; in all, 26,290 yds.															
Labor in hours and quantities of materials	24	81	166	193	329	156	49	10	128	1,136	1,647	82.35T	....	....	.....
Wages and prices	$0.22½	.30	.22½	.22½	.20	.20	.10	.20	20	Av.21.1	.34½	.70	5%cst	50%cst	.....
Total costs	$5.50	24.30	37.35	43.42	65.80	31.20	4.90	2.00	25.60	240.07	568.21	57.55	28.41	28.78	923.02
Cost per sq. yd.	....	....	....	....	....	....	....	....	....	.009	.022	.002	.001	.001	.035
No. 3—15,892 sq. yds.															
Labor in hours and quantities of materials	20	51	96	116	287	71	90	....	....	.....	987	49.35	....	....	.....
Wages and prices	$0.20	.30	.22½	.20	.20	.20	.10	....	....	.....	.47	.70	4%cst	50%cst	.....
Total costs	$4.00	15.30	19.35	23.20	57.40	14.20	9.00	....	....	142.45	463.89	34.55	18.55	17.28	676.72
Cost per sq. yd.	....	....	....	....	....	....	....	....	....	.009	.029	.002	.001	.001	.042
No. 4—9,900 sq. yds.															
Labor in hours and quantities of materials	35	29	84	68	185	65	76	92	....	.....	664	33.2	16	....	.....
Wages and prices	$0.20	.40	.22½	.20	.20	.20	.10	.20	....	.....	.50	.70	4%cst	50%cst	.....
Total costs	$7.00	11.60	18.90	13.60	37.00	13.00	7.60	18.40	....	127.10	332.00	23.24	13.38	11.90	507.32
Cost per sq. yd.	....	....	....	....	....	....	....	....	....	.013	.034	.002	.001	.001	.051
No. 5—32,167 sq. yds.															
Labor in hours and quantities of materials	105	139	246	422	728	257	106	....	....	.....	2,364	118.2	83	....	.....
Wages and prices	$0.20	.40	.22½	.20	.20	.20	.10	....	....	.....	.53	.70	4%cst	50%cst	.....
Total costs	$21.00	55.60	55.35	84.40	155.60	51.40	10.60	....	....	433.95	1,252.92	82.74	50.12	41.37	1,861.10
Cost per sq. yd.	....	....	....	....	....	....	....	....	....	.013	.039	.003	.002	.001	.058

EXPANSION JOINTS.

	Common labor.	Foreman.	Fireman.	Barrels pitch.	Totals.	Grand totals.†
No. 1—20′ Alleys, 6,013 yds.						
Labor in hours and quantities of materials	32	....	....	3	.....	.....
Wages and prices	.22½	....	....	4.80	.....	.....
Total costs	7.20	....	....	14.40	21.60	$8,002.03
Cost per sq. yd.	....	....	....	.....	.004	$1.344
No. 2—30′ × 40′ Streets, 5,933′ of St. car track; in all, 26,290 yds.						
Labor in hours and quantities of materials	310	50	50	23½	.....	.....
Wages and prices	.20	.30	.25	4.80	.....	.....
Total costs	62.00	15.00	12.50	179.60	269.10	$32,024.30
Cost per sq. yd.	....	....	....	....	.0102	$1.253
No. 3—15,892 sq. yds.						
Labor in hours and quantities of materials	308	10	....	36	.....	.....
Wages and prices	.20	.40	....	4.80	.....	.....
Total costs	61.60	4.00	....	172.80	238.40	$21,492.50
Cost per sq. yd.	....	....	....	.011	.015	$1.352
No. 4—9,900 sq. yds.						
Labor in hours and quantities of materials	200	10	....	22	.....	.....
Wages and prices	.20	.40	....	4.80	.....	.....
Total costs	40.00	4.00	....	105.60	149.60	$13,724.33
Cost per sq. yd.	....	....	....	.011	.015	$1.384
No. 5—32,167 sq. yds.						
Labor in hours and quantities of materials	451	....	....	51	.....	.....
Wages and prices	.20	....	....	4.80	.....	.....
Total costs	90.20	....	....	244.80	335.00	$45,463.18
Cost per sq. yd.	.003	....	....	.008	.011	$1.413

*100 lbs. per sack of cement.
†Does not include grading.

SANITARY INVESTIGATION OF THE MOHAWK RIVER DRAINAGE AREA.

The engineering division of the New York State Department of Health has been investigating the sanitary condition of a number of the streams and lakes of the State. The latest stream to be taken up is the Mohawk River, which is reported on in the Bulletin of the department for February, 1908.

The Mohawk River rises about 40 miles east of Lake Ontario and 20 miles north of the city of Rome, and after flowing across the State discharges into the Hudson River a little above Troy. The drainage area includes a total of 3,493 sq. mi., reaching from the Adirondacks on the north to the Catskills on the south. The population on the drainage area as a whole is not dense, but it ranges from 31 per sq. mi. in Herkimer County to 233 in Montgomery County. The cities of Utica, Schenectady, Cohoes, Amsterdam, Gloversville, Little Falls, Johnstown and a small part of Rome, with a total population of 211,000, are located on the Mohawk drainage area. In addition there are 37 incorporated villages in the drainage area with a total population of 58,000. A population of 104,000 in more rural sections brings the total population on the drainage area up to 372,000. The average densities of population are 107 per sq. mi. for the total population, 47 if cities are omitted and 30 if cities and villages are omitted.

The dry weather flow of the Mohawk is materially lessened by the withdrawal of some 800 cu. ft. per sec. of water for supplying the Erie Canal.

Besides the pollution due to municipal outfall sewers, a considerable amount of factory waste is discharged into the Mohawk. The dry weather flow of the Mohawk and its tributaries is insufficient to so dilute the sewage it receives as to prevent a nuisance at some points. The most serious feature of the pollution, however, is its relation to the water supplies of Utica, Cohoes and West Troy. The water supply of Utica is drawn from West Canada Creek, and is protected by sanitary rules formulated by the State Department of Health. The high death rates from typhoid fever and diarrheal diseases at Cohoes and West Troy indicate the serious character of the pollution of the Mohawk at the water-works intakes of these places.

Prior to the amendment of the public health law of the State in 1903, there were no means at the command of the State Department of Health for checking the pollution of the Mohawk. The legislation of that date, the Bulletin already mentioned states, affords the department no more than a check on the pollution, since it gives the department control of plans for new sewage disposal schemes only, leaving the flow from existing outfall sewers beyond the prohibition of the Department.

Since the passage of the act of 1903, the State Department of Health has refused to approve plans for sewerage systems in the Mohawk Valley, unless those plans contain provision for sewage purification works. The villages of Whitesboro, New Hartford, Dolgeville, St. Johnsville, Ilion, Frankfort, Mohawk, Fort Plain, Canajoharie, Sharon Springs, Scotia, Fonda, Cohoes, and the cities of Gloversville, Amsterdam and Schenectady, have all submitted plans which include sewage disposal works, and in none of these cases have permits been issued without a condition requiring the immediate construction of these disposal works, or their construction within a time specifically stipulated or limited to the discretion of the State Commissioner of Health.

The Bulletin states that some of the villages along the Mohawk have been guilty of violating the public health laws, either in the matter of filing plans and reports required under the act of 1903, or else by the illegal discharge of sewage into the river. A special investigation of this matter is being made by the State Department of Health as a preliminary to bringing legal proceedings against the offending municipalities.

The conclusions and recommendations of the report on the Mohawk investigation, as given in the Bulletin, are as follows:

In view, therefore, of the serious and unwarranted pollution of the Mohawk River which now exists as a result of the discharge therein of the sewage and waste from the vast population and numerous industries located upon its watershed; of the menace to the health and lives of the communities which reside along its course and must depend upon its water for sources of water supply; and of the detriment to comfort and convenience of those who live along its banks or use these waters in their daily life or industrial pursuits, it will be the policy of the department to direct every power vested in the State Department of Health by the Public Health Law toward the reclaiming of the purity of these waters and the protection of the health of those communities who use the same for potable purposes by:

(1) Prohibiting entirely the discharge of any additional unpurified sewage or industrial wastes into these waters.

(2) Requiring the removal of all existing pollution from domestic sewage and trade wastes by the installation of such methods of sewage purification as will remove as far as practicable all matter of a dangerous or objectionable nature.

(3) Demanding a degree of purification of sewage and industrial wastes from all cities and villages situated along the river, and its main tributaries, as will produce a non-putrescible effluent.

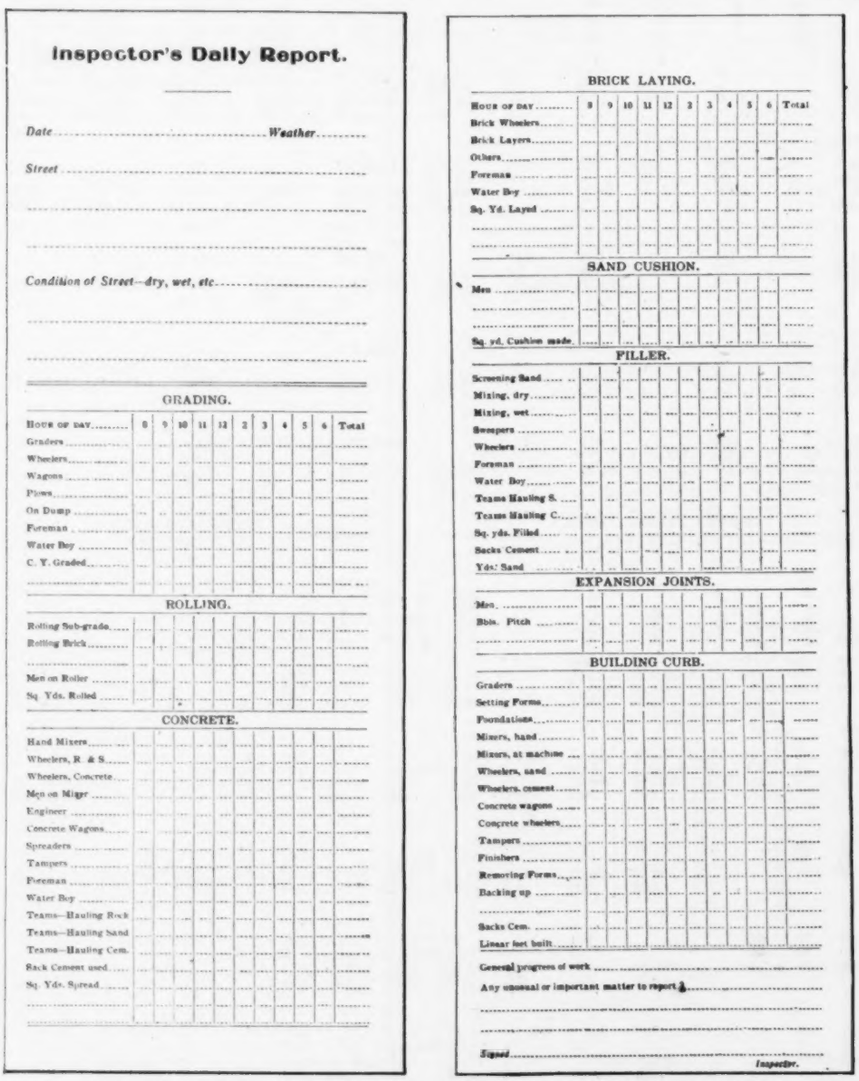
(4) Inducing all communities which now or may use the unfiltered Mohawk River or its tributaries for water supply purposes, to filter these supplies.

FREIGHT MOVEMENT ON THE GREAT LAKES in 1907 exceeded all previous figures, with 83,388,000 tons, an increase of 10% and 20% respectively over the figures of the two preceding years. Most of the increase is in coal and ore shipments. Iron ore makes up almost half of the total, namely, 41,000,000 tons. The harbor of Duluth and Superior contributed 20,500,000 tons of this, Two Harbors, 8,000,000, Escanaba 5,600,000. Ashland 3,400,000, Marquette 1,700,000 and Presque Isle 1,200,000 tons. Most of the ore went to Lake Erie ports. The principal receiving ports for ore were Ashtabula, Cleveland, Conneaut, Buffalo, Lorain, Fairport, Erie, Toledo, Huron and Sandusky, which took 35,000,000 tons. Grain shipments, also eastward, amounted to about 142,000,000 bushels, originating mainly at Lake Superior and Lake Michigan points. Wheat shows a 33% increase over 1906, while corn shipments remained about the same and oats and barley decreased. By far the most of the grain went to Buffalo. About 13,000,000 bbls. flour were shipped from the upper lakes, a slight decrease. Lumber shipments amounted to 1,400,000 M. feet, a decrease of 500,000 over 1906, and a decrease of 42% since 1901.

Westbound freight comprised 15,300,000 tons soft coal from Lake Erie points to the upper lakes, and 4,000,000 tons hard coal from Buffalo, Oswego and Erie.

The freight movement through the Sault Ste. Marie canals (American and Canadian) totaled 45,500,000 tons eastbound and 12,700,000 tons westbound, or 58,200,000 tons in all, an increase of about one-eighth over 1906. The principal eastward freight, iron ore, and the principal westward freight through the canals, coal, show increase over the preceding years, but grain showed no increase, while lumber and general merchandise showed decrease. The number of vessels passing through the canals in 1907 was 20,437, a decrease over previous years, while the aggregate net register tonnage increased to 44,100,000 tons. This indicates the increase in average size of vessels used in the traffic between upper and lower lakes, which size, as deduced from the canal records, was 1,689 tons, 1,855 tons and 2,157 tons, respectively, in the last three years. In 1899 the corresponding figure was only 1,080 tons.

The traffic through Detroit River in 1907 was 67,300,000 tons, comprising 47,000,000 tons southbound and 20,300,000 tons northbound. The total vessel movement as well as the total tonnage was larger for the Detroit River, however, than for the Soo, being 23,721 vessels aggregating 48,958,238 register tons; the average per vessel was 2,062, practically identical with the Soo figure.



Inspector's Daily Report.

Date ..... Weather .....

Street .....

Condition of Street—dry, wet, etc. .....

GRADING.

Hour of day	9	9	10	11	12	2	3	4	5	6	Total
Graders											
Wheelers											
Wagons											
Plows											
On Dump											
Foreman											
Water Boy											
C. Y. Graded											

ROLLING.

Rolling Sub-grade											
Rolling Brick											
Men on Roller											
Sq. Yds. Rolled											

CONCRETE.

Hand Mixers											
Wheelers, R. & S.											
Wheelers, Concrete											
Men on Mixer											
Engineer											
Concrete Wagons											
Spreaders											
Tampers											
Foreman											
Water Boy											
Teams—Hauling Rock											
Teams—Hauling Sand											
Teams—Hauling Cem.											
Rock Cement used											
Sq. Yds. Spread											

BRICK LAYING.

Hour of day	9	9	10	11	12	2	3	4	5	6	Total
Brick Wheelers											
Brick Layers											
Others											
Foreman											
Water Boy											
Sq. Yd. Layed											

SAND CUSHION.

Men											
Sq. yd. Cushion made											

PILLER.

Screening Sand											
Mixing, dry											
Mixing, wet											
Sweepers											
Wheelers											
Foreman											
Water Boy											
Teams Hauling S.											
Teams Hauling C.											
Sq. yds. Filled											
Sacks Cement											
Yds. Sand											

EXPANSION JOINTS.

Men											
Bbls. Pitch											

BUILDING CURB.

Graders											
Setting Forms											
Foundations											
Mixers, hand											
Mixers, at machine											
Wheelers, sand											
Wheelers, cement											
Concrete wagons											
Concrete wheelers											
Tampers											
Finishers											
Removing Forms											
Backing up											
Sacks Cem.											
Linear feet built											

General progress of work .....

Any unusual or important matter to report .....

Signed ..... Inspector.

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In the late '70's the U. S. Congress created a National Board of Health. After a few years of existence, during which some good work was done, the Board finally died of starvation. From that time to this, there has been more or less frequent and insistent agitation in various quarters for the re-establishment of the Board. The nearest approach to such action, in effect, though not in name, was the recent enlargement of the powers, duties and title of the U. S. Marine-Hospital Service, which since the enlargement has been known as the U. S. Public Health and Marine-Hospital Service. Under the terms of the bill introduced in the House of Representatives on March 6, 1908, a still further enlargement of the Service is provided for, and one which would go far towards raising that Service to the plane of a national board of health in all except name. Elsewhere in this issue we reprint the bill in full, and to it we append a brief history of the old National Board of Health.

Important as are the portions of the bill that provide for special investigations of tuberculosis, typhoid fever and other diseases, for a school of hygiene, and for enlarging the work of the Advisory Board of the U. S. Public Health and Marine-Hospital Service, it is probable that readers of Engineering News will be more interested in the clauses of the bill that provide for "a bureau division of water supplies and sewerage." This division is to be headed by a commissioned medical officer of the Public Health and Marine-Hospital Service, who, while serving, shall have the title of Assistant Surgeon-General. In addition, the Secretary of the Treasury, on recommendation of the Surgeon-General, is required to appoint "a sanitary engineer competent to solve technical problems connected with the purification of water and sewage," at a salary not to exceed $5,000 per annum, and also a solicitor "who shall be familiar with the public health laws of the National Government, States and municipalities, to aid in establishing uniform measures for the protection of the public health, and to perform such service of a legal nature as may be required," at a salary not over $5,000 a year.

Whatever one's opinions may be as to the desirability of creating a full-fledged national department of health, either as a bureau of one of the cabinet offices, or, as some have urged, under a new cabinet officer, there is certainly much to be said in commendation of any plan which makes for immediate increase in the amount and efficiency of health-protective work done by the National Government. Until those competent to decide have pronounced more definitely than has yet been done upon the proper functions of a national health department and the best means of creating one, it is certainly best to increase the work of some branch of the Government already equipped for such work and with experience in doing it. As matters now stand, the organization in existence best equipped to take up the laboratory portions of the work is the U. S. Public Health and Marine-Hospital Service. So far as water supply and sewerage investigations are concerned, particularly those bearing directly upon stream pollution, the work already done in this line by the Hydrographic Department of the U. S. Geological Survey has put it in possession of so much information, and trained so many men, that it would seem logical to continue and extend this work through the Geological Survey rather than through an entirely separate branch of the Government, quite unfamiliar with such investigations. There is, however, a great deal to be said in favor of placing all national health-protective work under one jurisdiction. We have repeatedly urged this for the several States and it is equally advantageous for the United States.

The construction of the Grand Trunk Pacific Ry., which is the new Canadian transcontinental line, is making steady progress even though the spectacular rapidity of the work that was at one time predicted (for completion in 1911) has not been realized. The general project was described at some length in Engineering News of Oct. 22 and Nov. 5, 1903. The main transcontinental line will be about 3,555 miles in length, while important branches will bring the total length of the system as planned up to about 8,000 miles. Two very important branches will extend southward from the main line; one of these (about 250 miles in length) will touch North Bay, Ont., connecting with railway lines to Toronto and Montreal. The other extends to a lake port terminal at Port Arthur, on Lake Superior (about 200 miles).

With the completion of that part of the line from the vast agricultural regions of the northwest to a lake port, the railway will be in position to handle an important share of the wheat traffic, while construction proceeds on the eastern and western portions of the line.

Over 4,200 miles of this ambitious railway system have been surveyed, and the location has been made for the entire length of the main line, although revisions are still in progress on the Rocky Mountain and Pacific Division. There are now 1,900 miles under contract and under construction, 1,200 miles have been completed to grade, including the construction of trestles, etc., and 600 miles of track have been laid.

The located line is remarkable for the low grades and easy curves that have been secured. Even on the mountain division there is nothing steeper than 1% grade, and that for only a few miles. For the 1,800 miles between the Atlantic connection with the Intercolonial Ry. at Moncton, N. B., and the city of Winnipeg (which is the portion being built under the direction of the Transcontinental Railway Commission of the Canadian Government), the maximum grades are 0.4% against eastbound and 0.6% against westbound traffic. Between Winnipeg and Battle River (650 miles), the maximum grades are 0.4% against eastbound and 0.5% against westbound traffic. From Battle River through the Rocky Mountains to the Pacific terminal at the new city of Prince Rupert the maximum grades are 0.4% each way, with the exception of 20 miles of 1% against eastbound traffic on the west side of the mountains.

The sharpest curves between Winnipeg and the Rocky Mountains are of 3°; through the mountains and on the line between Winnipeg and the Atlantic the maximum is 6°. The road is being substantially built, with a view to heavy traffic and economical operation, and the track is being laid with 80-lb. rails. The bridges and trestles are designed for a live-load consisting of 50,000-lb. engine wheel loads and a train load of 48,000 lbs. per ft. of track. The tunnels are 16 ft. wide and 24 ft. high in the clear.

One of the interesting features of the work is the planning and construction of a new city at the Pacific terminal, to be named Prince Rupert. This will include provisions for extensive railway terminals and an elaborate railway passenger terminal station, together with harbor facilities, steamship piers, etc. Detail plans are now being prepared jointly by the railway engineers and a firm of landscape architects, and it is expected that the setting out of blocks and lots will be commenced by June of this year.

Mr. H. D. Lumsden is Chief Engineer for the Transcontinental Railway Commission, having jurisdiction over the eastern section of the line. Mr. B. B. Kelliher is Chief Engineer of the Grand Trunk Pacific Ry., which is building the line from Lake Superior to Winnipeg and the Pacific. This company will also operate the entire line when it is completed.

RECORDS IN ROCK TUNNELING.

A high figure of monthly progress in rock tunnel driving was made recently on the Gunnison Tunnel, Colorado. In January, 1908, we are informed by Mr. H. L. Daniels, Engineer U. S. Reclamation Service and Superintendent of River Portal, a length of 449 ft. of heading was driven in the river end of this tunnel. The heading is in granite, and measures about 8½ × 12 ft., slightly above the usual size of tunnel heading. As will be shown below, this is a higher monthly advance than any other American rock tunnel has shown. Figures of 250 to 350 ft. are the best hitherto made, except on the Sutro Tunnel, where a single heading [apparently] made an advance of 417 ft. in a single month. At the same time the European records are far above these figures. All the Alpine tunnels have made faster progress in their best months, and about four years ago the Simplon Tunnel made the present world's record of 685 ft. in one month in a single heading.

The interest of the subject is derived from the fact that tunnel work is by its very nature a constant striving for fastest possible advance of heading. The time needed to complete the entire tunnel, and consequently the period during which the invested capital lies idle, are wholly dependent on the speed with which two small headings can be pushed forward. Only a small party of men can work in each heading; concentration of working forces upon the critical point is not possible. Therefore, while all engineering construction has speed of working as one desideratum, in the case of tunnel headings it assumes a surpassing importance.

High efficiency of tools and methods are obviously the main controllable factors in determining the rate of progress of a tunnel. But it must not be forgotten that the natural conditions which the work encounters are far more influential. Unfavorable direction of the strata, fissured rock, swelling rock, subterranean water flows, and even fire-damp such as stopped all work in the Ricken Tunnel headings for nearly a year: these are obstacles more powerful to retard progress than perfected working methods and efficient tools are to accelerate it. As few tunnels are free from special difficulties of these and other kinds, the mean rate of progress for the whole penetration is no criterion of performance. We must look to the highest month's work as the gage of accomplishment. Where the rock is firm, solid and dry, a month's work may exceed by two to one the ordinary rate of advance, and by still larger ratio the average rate for the entire work.

We have compiled, rather hastily, some figures of maximum rates of progress made in the prin-

cipal rock tunnels in Europe and America. As already remarked, the preëminence of the Alpine tunnels in this regard is clearly apparent from these figures. What is especially remarkable in this is the fact that we cannot account for the difference between the European and the American records by any differences in the tools used. It is true that the Brandt rotary drill was employed in most of the cases where notable rates of progress were attained. But to offset this we have practically equal records made with percussion drills. Thus, in the Loetschberg Tunnel, now being driven, where both headings are using percussion drills, of different makes, the figures of maximum and average progress are rapidly approaching the best Simplon Tunnel records, although the work has been going on less than a year. In the construction of the Arlberg Tunnel a quarter of a century ago, Ferroux percussion drills were employed in one heading and Brandt rotary drills in the other; phenomenal rates of progress were attained, but the best month's records in the two headings differed by less than one per cent. Still more remarkable, perhaps, is the fact that in the Ricken Tunnel, in northeastern Switzerland, hand-drilling alone has shown rates of progress that rank among the high figures, and, though far below the Arlberg, Simplon, Albula and Loetschberg records, are higher than any American results.

The following are the progress figures which we have compiled. They are in all cases the greatest advance made in any one month, in feet, for a single heading:

Mt. Cenis Tunnel, Alps (1857-1870): 297 ft. Machine drilling.

Hoosac Tunnel (1865-1873): 184 ft. (west hdg. from central shaft). Machine drilling.

Nesquehoning, Pa., Tunnel (1871): 165 ft. (South heading.) Machine drilling.

Sutro Tunnel, Nevada (1869-1877): 417 ft. [One or several headings?]

Musconetcong Tunnel, New Jersey (1872-1874): 144 ft. (West heading.) Machine drilling.

St. Gothard Tunnel, Alps (1872-1881): 436 ft. (343 ft. per month average for one entire year). This is the only Alpine tunnel driven by top heading.

Arlberg Tunnel, Alps (1880-1883): East heading, Ferroux percussion drills, March, '82, 556 ft.; April, '83, 594 ft.; May, '83, 610 ft.; July, '83, 613 ft.; August, '83, 637 ft. West heading, Brandt rotary drills, June, '82, 509 ft.; August, '82, 527 ft.; May, '83, 625 ft.; July, '83, 641 ft.

Stampede Tunnel, Northern Pacific R. R., Washington (1886-1888): 274 ft. This tunnel was driven under very great pressure to construct it rapidly. Machine drilling.

New Croton Aqueduct Tunnel, New York City (1887): Denton, Breuchaud & Co. made a special trial record of one week, 127 ft., equivalent to a rate of 550 ft. per month. This was in hard rock, in an unusually large heading, 140 sq. ft. Ordinary progress was only about 175 ft. per month.

Busk Tunnel, Colo. Midland Ry. (1890-1893): 2021½ ft. Much bad rock was encountered.

Cascade Tunnel, Great Northern R. R., Washington (1897-1900): 301 ft.

Kellogg Tunnel, Bunker Hill & Sullivan Mines, Idaho (1898): 345 ft.

Aspen Tunnel, Union Pacific R. R., Wyoming (1901): 306 ft.

Albula Tunnel, Alps (1900-1902): Sept., 1901, 558 ft.; Dec., 1901, 607 ft. Very hard rock, Antigorio gneiss. Brandt rotary drills.

Karawanken Tunnel, Austrian Alps (1902-1905): August, 1903, 552 ft.; June, 1904, 544 ft.; July, 1904, 553 ft.

Bosruck Tunnel, Austrian Alps (1902-1905): February, 1905, 546 ft.; March, 1905, 526 ft.

Simplon Tunnel, Alps (1900-1905): December, 1902, 682.2 ft. (North heading); July, 1904, 683.5 ft. (South heading). These figures represent the world's record. In both headings the work was interrupted and delayed by bad rock and water shortly after these maximum rates of advance had been attained; had it not been for this, still better figures might perhaps have been realized.

Tauern Tunnel, Austria (1902-1907): October, 1904, 548 ft. Over 525 ft. nearly every month throughout 1905, with 540 ft. in November and 546 ft. in July; June, 1906, 546 ft.

Ricken Tunnel, Switzerland (1903- ——): January, 1905, 452 ft.; June, 1905, 461 ft.; June, 1906, 413 ft.; November, 1907, 358 ft. *Hand drilling* alone has been used. Early in 1907 work was stopped for nearly a year by strong flows of fire-damp.

Loetschberg Tunnel, Switzerland (1906- ——): August, 1907, 555 ft.; September, 1907, 574 ft.; October, 1907, 538 ft.; November, 1907, 558 ft.; January, 1908, 551 ft. Both headings use percussion drills, one of European make, the other American. This tunnel is among the longest Alpine tunnels, and its early completion is very desirable for certain traffic routes. As the above high rates were made very soon after the beginning of work, it is not impossible that the Simplon record may be threatened before the completion of the tunnel.

Most of the Alpine tunnels pass through hard, dense rock for the greater part of their length. In fact the best records of the Simplon were made, we believe, in an unusually hard material, the Antigorio gneiss.

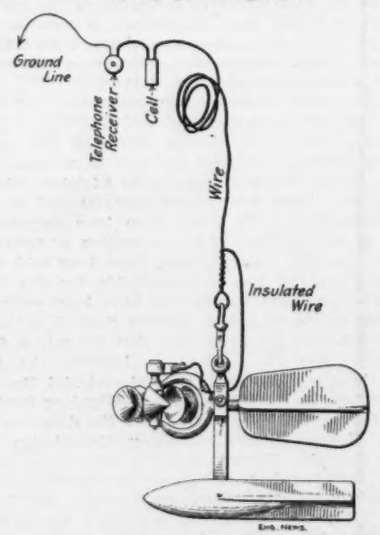
It is evident that the Gunnison Tunnel record quoted at the beginning of this article is notable only as an American record. The Alpine tunnel figures far surpass it, and it is exceeded even by the hand-drill record on the Ricken Tunnel.

Clearly, American rock tunnel construction has not yet reached its greatest development. European tunnel constructors universally prefer the bottom heading method, while in America the top heading is always used. Is this difference responsible for the difference in maximum progress rates? Or is not a sufficient explanation found in the greater length of the principal Alpine tunnels and the resulting economic possibility of installing more perfect plant and arranging a more thorough organization? We will not attempt an answer to these questions, but restrict ourselves to noting the fact, which is as curious as the differences in speed of battleship construction which English and American shipyards show.

LETTERS TO THE EDITOR.

Suspending a Current Meter from a Single Electrical Circuit Wire.

Sir: A method of suspending the current meter, which is being used successfully in the stream gaging work of the U. S. Geological Survey in California, will, I believe, be of interest to hydrographers in general.



Suspending a Current Meter from a Single Electrical Current Wire.

The method is to suspend the meter from a single wire of sufficient strength to sustain the weight of the meter and the current of the water, and to employ the ground and water to complete the circuit which is necessary to operate the recording or indicating appara[tus] instead of using the insulated cable, containing a [se]parate circuit, which is now in general use. The wire [is] insulated from the body of the meter, but is connec[ted] with the spring in the head of the meter which make[s] and breaks the circuit. The other end of the wire pas[ses] through the battery cell and telephone rec[eiver] and is connected with a conductor leading to the g[round]. This conductor may be the station cable, a brid[ge] iron, or, if measurements are made from a wood[en] bridge, a wire grounded at one end, and stretched alo[ng] the guard rail will do.

On account of the small resistance wh[ich] the wire offers to the current, as compared with th[e] cable, the meter may be used in streams of great dept[h] and velocity without the use of extra weights or stay [lines].

Very respectfully,

Wm. A. [illegible],
Asst. Engineer, U. S. Geological Survey.

Sacramento, Cal., March 6, 1908.

The Mean Load for the Average Burro.

Sir: In reference to the letters of W. L. [illegible]son and C. W. Comstock in your issues of Nov. 7 and 28 respectively, on the subject of proper loads for burros, the writer is inclined decidedly to favor the opinions of the former.

The Mexican burro is little, if any, larger and stronger than the burro of the plateaus of Bolivia.

Several engineers here now, who know Mexico from north to south, and who are especially acquainted with ore packing there, agree in calling 150 lbs. a good load for the average Mexican burro.

Where trails are bad there is not as much difference between the work performed by a loaded animal in ascending a hill and in descending same as might be expected. A good proof of this is the heavy breathing of a saddle mule with a rider when near the bottom of a long slope.

The writer was in camp in Bolivia, the land of pack animals (and especially burros), for 1½ years, during which time he never saw a mule on a long journey with a load as heavy as 400 lbs. The average mule load is about 275 lbs., and 150 lbs. is a good load for a burro.

Yours very truly,

John K. Flick,
Asst. Engr., Madeira-Mamoré Ry. Co.

Santo Antonio (Rio Madeira), Amazonas, Brazil, S. A., Jan. 15, 1908.

More Concerning Civilian Engineers for Federal Public Works.

Sir: Regarding the discussion in your columns as to army engineers versus civilian engineers for public works, there is probably very little difference in the character of men in engineering work in the army corps or in civil life. Whatever difference of ability there may be is individual or the result of particular experience.

West Point, of course, is not as essentially an engineer school as many others. Its graduates do not begin at the bottom with chain, rod or T square and have to make their way to the top through all the steps by sheer ability. Thus the civilian engineer has a more thorough training than the officer, who is foisted into a full fledged engineer job at the start without any particular sifting process as to ability. The paternal government pays for and accepts his mistakes in getting experience without dismissal or much regard for cost. If his river or harbor work does not pan out, he still goes on and up in rank, while if a civilian engineer fails to get results he is down and out at once to make room for a better man. Therefore, it must be agreed that *all* the engineers of the army cannot be of a superior grade because there is no natural sifting process—and this without any intended disrespect to the capable members of the Corps.

The writer, having been through the "turmoil" of the Isthmian Canal starting, as Mr. Gillette is pleased to call it, has to submit certain facts seemingly overlooked by that critic. In the first place he evidently forgets the army officer of high rank who led off in that turmoil, also that there were army officers under both Wallace and Stevens, and on the Commission; but, with all respect to them, the writer has no remembrance that any one noticed any transcendent effects of their presence on the wretched conditions which faced us any more than that of the ordinary "maverick" in engineering life; but they did their work, and the writer recognizes it in full. Possibly, Mr. Gillette can explain, on account of the army, why there is always similar "turmoil" in getting started in a great undertaking with bad conditions, even if it is officered by army men, as the Spanish or Civil War.

It should be noted in this connection by the writer that Col. Goethals and his associates have been entirely just in regard to the credit due their predecessors. Their statements fully recognize the difficulties of the pioneer work, and that they came in after it was practically finished. It is probable that when Chief Engineer Stevens left, the organization then established could have gone on six months or more without a head. In fact the new Commission made no important changes in that time.

There are in the practice of the army engineer corps the wreck of some projects in river and harbor work at large cost, possibly no more than the usual proportion in general practice, but it is certain that the best engineering talent of the United States was not called in. No one can, however, segregate and weigh the successes and failures of any body of professional men and fix definite superiority, but it seems to me that, as work is getting slack, the Reclamation Service could if necessary take up the river and harbor work and carry it on as well as the army engineers.

If our nation is to have the best engineering talent for its internal improvement works, its service should be open to all according to merit. It is one of the secrets of the universe how Genius comes or where; and it certainly is not a product of any particular college, be it West Point, Annapolis, Harvard, Yale or Cornell, and some of the world's greatest engineers never saw a college. Neither is morality or business honesty a particular monopoly of the army engineer corps, in comparison with civilian engineers. No training can instil genius, nor can it insure against moral obliquity. The record of the engineer corps to which Mr. Gillette refers with just and pardonable pride is hardly a fair argument, for such records are not subject to review, but good or bad are buried by a paternal government somewhat in the way the doctors are said to bury their mistakes. Further, the Government is a lax employer in comparison with business men who expect a project to earn money.

Very respectfully,

March 16, 1908. B. E.

Designing by Manufacturers and the Functions of the Consulting Bridge Engineer.

Sir: In your issue of Feb. 13 appears a communication from Mr. J. A. L. Waddell on "The Functions of the Consulting Bridge Engineer." This letter brings up the general subject of the relations of bridge specialists to the general profession. The apparent inference from the letter is that the bridge engineer should design the entire structure in all details if he is to be free from the charge that he "is shirking his work and is not earning his pay" as Mr. Waddell puts it. Inasmuch as the practice of leaving the detailing and even general design of bridges to manufacturers is so universal, it would appear that either the profession in general does not agree with Mr. Waddell or else the profession is of a low moral fiber. The latter is hardly the case.

I have no disposition to state that the bridge engineer is not a valuable addition to the profession, but I do dispute the inference that he should be given full charge of the designs, both general and detail, and that the present American practice is bad. The reasons that have brought about this condition are well known. The ordinary purchasers of bridges, such as railroads, traction lines, counties and cities, have in their employ an engineer for general purposes, who is not a bridge specialist. Naturally this engineer does not attempt to design all details, realizing that to secure economical results the design must accord to shop practices of which he knows little. He calls for plans and specifications from the manufacturers and then advises his employers as to the best plan for the amounts bid. He recognizes that his true function is to procure for his employer the best design at the least cost. This commercial function must be recognized by all engineers.

The greater portion of the money spent on bridges is for small structures. The ordinary engineer, as outlined above, is capable of selecting with intelligence from the bridges offered him. How absurd it would be if a manufacturer in buying a 100-HP. engine would ask for bids on plans prepared by a consulting mechanical engineer! It is no more necessary for the engineer to detail the bridge than it is for the manufacturer to design the engine.

If the practice of having bridge builders design details and even general plans had not been successful, it would have been nipped in the bud fifty years ago. To-day it is almost universal and stands as a monument to the honesty and ability of American bridge manufacturers. Your editorial of Nov. 28 is correct. In contradiction to Mr. Waddell's inference that this practice is not for the good of the engineering profession, I am sending this letter.

Yours truly,
Alex. R. Holliday, Secretary,
The National Concrete Co.

Indianapolis, Ind. March 13, 1908.

Is an Applicant for a Position Entitled to a Reply?

Sir: May I use a portion of your space for the statement of what is no doubt an old grievance? Probably many others have been vexed by the same problem, and doubtless it is irremediable, yet it may not be utterly futile to register a public protest.

In every issue of your paper and of most other engineering periodicals there are several "Situations Open" advertisements. Each one of these presumably brings forth a multitude of applicants, all but one of whom are necessarily destined to be unsuccessful. Every one of them understands this and knows that his chance is rather small, but nevertheless, every one of them who writes a courteous letter and encloses either a stamp or an envelope for a reply, is, it would seem, entitled by common courtesy to a reply. To about two-thirds of an applicant's letter he does get an answer; to the rest he does not. This is not a guess as to the per cent. of replies. I have before me copies of 25 applications, with every one of which a stamp was enclosed. Seventeen of them received replies; eight were never heard from.

Is a man, who in good faith answers an advertisement and who observes every rule of business courtesy in so doing, entitled to similar consideration from the advertiser, or is the latter, in this particular branch of his business, absolved from the obligations under which the rest of it is conducted?

Respectfully yours, A Victim.

[Courtesy calls for a reply but business conditions sometimes make it very difficult to send replies to a long list of applicants. For example, a chief engineer is organizing parties to carry out surveys for a new enterprise, and is rushed with work. Very likely his clerical staff for conducting correspondence may be limited or even nonexistent. The task of writing 20 to 50 letters to unsuccessful applicants for each of two or three positions may be practically impossible to accomplish in view of other demands on his time.

Naturally, an applicant for a position watches the mails for an answer, and it is a satisfaction to him to know at least that his letter was received and given attention, even though the reply be unfavorable. If the one who receives the applications will put himself in the place of the writers, he will certainly send answers unless circumstances make it impracticable. He may be applying for a position himself, some day.—Ed.]

Notes and Queries.

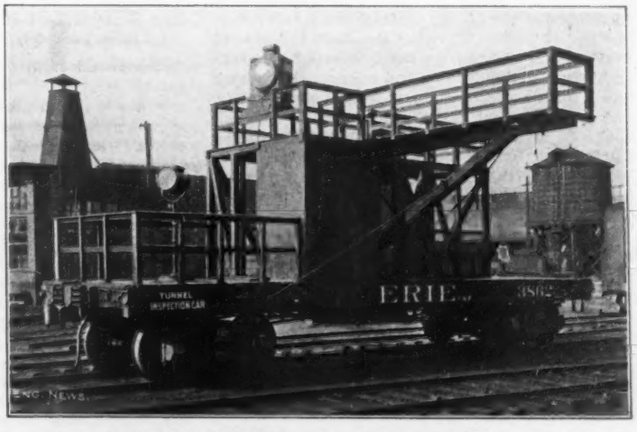
In the "General Formulas for Simple Curves," given by Mr. J. Calvin Locke in our last issue (pp. 347-348), there is a typographical error in one of the formulas for the radius. It should read

$$R = \frac{d^2}{2m} = \frac{c^2 + 4m^2}{8m}$$

As given, the exponent of the m in the numerator was omitted.

TUNNEL INSPECTION CAR: ERIE R. R.

The tunnel inspection car, shown in the accompanying figure, was constructed for use on the work in the new tunnels of the Erie R. R. under Bergen Hill, N. J.* The car is fitted with a raised platform and a swinging gangway which can be opened to the position shown in the figure for the inspection of the tunnel roof over tracks parallel to that on which the car is running. When this extension is not in use it may be swung up snugly to the platform and there locked; the work of changing requires but a minute. On the car floor is a revolving projection searchlight with extension shaft and set screws. On the raised platform is a standard locomotive headlight, mounted so that it may be revolved in any desired direction. Both of these lamps are equipped with acetylene-gas burners and are connected by flexible connections and fixed piping to two acetylene storage tanks, having a capacity of 600 cu. ft. each, housed under the elevated platform. One of these tanks is constantly in use and the other is held filled in reserve. The car has been found successful in the work for which it was designed, especially in the inspection of the tunnel roofs after blasts. It is intended for use also by the Engineering Department in connection with any elevated work they may be called upon to do in the tunnels. The design was made under the direction of the chief engineer of the Erie R. R., Mr. Francis Lee Stuart, M. Am. Soc. C. E., and Mr. George H. Burgess, Assoc. M. Am. Soc. C. E., Engineer of Terminal Improvements. The car was built at the North Paterson shops of the company.



TUNNEL INSPECTION CAR, FOR USE IN THE BERGEN HILL TUNNELS OF THE ERIE R. R., JERSEY CITY, N. J.

*The projected work in this project was described in Engineering News, Feb. 21, 1907.

SIGNIFICANT DEVELOPMENTS IN THE TEACHING OF ENGINEERING AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The report of the acting president of the Massachusetts Institute of Technology, Prof. A. A. Noyes, which has been published in pamphlet form with the reports of department heads, shows several interesting and significant changes in faculty organization and in the work of instruction. The report shows the policy that may be expected in the administration of this institution as an undergraduate and a graduate school.

FACULTY ORGANIZATION.

To more effectively carry on the administrative functions of the faculty the office of Chairman has been created as a position quite distinct from that of the President of the Institute.

On account of the size of the faculty its administrative work is carried out in detail by some 25 standing committees which have power to take final action except in actual changes of policy or procedure. In these cases the committees are expected to take the initiative in securing the approval of the general faculty.

DEVELOPMENTS IN INSTRUCTION.

ENTRANCE REQUIREMENTS.—The practice of the Institute concerning the entrance examinations in English literature is believed to be quite novel. The Institute accepts no specified list of books for reading or study as do other colleges and technical schools. Its catalog recognizes the list of the National Conference on Uniform Entrance Requirements as presumably adequate for proper literary training, but its entrance examination questions are not directly concerned with these or any other books which the student is assumed to have studied. The "literary questions" are intended to test the candidate's power of appreciating intelligently a selection printed upon the examination paper and presumably new to the candidate. This somewhat simplified system of entrance examinations has already shown indications of freer and less mechanical literary training in the preparatory schools. It is expected that this advantage will grow in the future.

MODERN LANGUAGES.—The second year work is now wholly or in greater part omitted in all the strictly engineering courses. It is thought by a majority of the faculty that few engineers make great practical use of their knowledge of modern language and that the general and technical work substituted has a higher

cultural value, in the first instance, and in the second provides a better mental training and equipment. The time gained has, in general, been divided about equally by increasing the instruction in English Literature and European History and by giving a more thorough drill in fundamental engineering subjects, especially in applied mechanics and steam engineering.

In the past year the English Department has instituted a new plan of "stratification," or of grading the new students according to ability. Upon the basis of the entrance examinations and two special tests at the first recitations, the freshmen are graded into three "layers" of capacity; the positively illiterate—including most foreign students—are in the bottom layer, the average ones are in the middle and the most promising are in the top. Mistakes in assigning students may be corrected at any time and a general rearrangement of grades occurs at the end of the half year. A similar scheme is being tried with a second year class in English literature. Sections able to advance are thus taken forward rapidly while with those sections which must go slower, a gradual progression is obtained which was not possible when one portion of the class as a whole was impatient to advance. Yet the amount and character of the work for each grade does not vary greatly. The lower grades are able to get over the ground by more effective individual attention and assistance by personal conference. A series of personal conferences between students and instructors has been arranged.

MATHEMATICS.—The old time-honored divisions of algebra, analytic geometry and of differential and integral calculus have been discarded and the whole field of these groups of studies has been covered by a two-year course. The principles of each of the old subjects are introduced as needed and all subjects are developed together. This change has been deemed advisable to give students a better grasp of mathematics as a whole and an adequate idea of the interdependence of the various branches and to accustom the men to the better selection of methods best adapted to the problems in hand. This early introduction of calculus and analytic geometry here has already been found advantageous in the other second and third-year lines of study. For instance, next year, as a result, the use of calculus in its simplest form will be introduced in the general course in physics. In the Department of Mathematics as in the English, the plan of individual conferences has been instituted. As it becomes possible this scheme of personal conferences will be extended broadly through all courses.

SUMMER READING.—All candidates for degrees, except college graduates, are required to complete courses of non-professional reading during the summers following the first and second year's work. Lists have been prepared of works on history, fiction, poetry and science. Each book has a certain credit value of from 5 to 25 points, and each student must read carefully enough books to give him a credit of 100 points. The English Department pointedly disclaims connection with the summer reading to emphasize the fact that it is not a requirement of the English Department but of a faculty of engineers. The English Department does not control, officially or unofficially, this course, which is in the hands of a committee of seven, only one of whom is from this department.

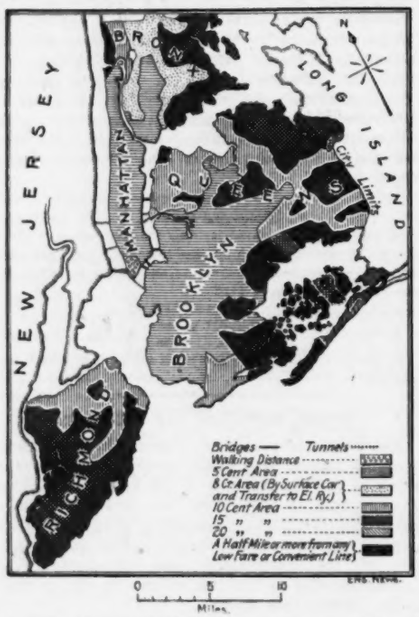
GRADUATE COURSES.—A recent decision of the faculty offers special inducements to graduates of other colleges to pursue advanced work here. These men are now permitted to enter on a course leading to the degree of Master of Science without previously taking the Bachelor's degree at the Institute. This course is to be completed in two or three years, according to previous preparation.

Fifth-year courses for graduates of the Institute have been thoroughly developed, leading to the degree of Master of Science. These are an extension of the four-year courses and each department is prepared to offer work of a more specialized character than can be given to undergraduates during their four-year courses.

Thus in civil engineering work is offered in the design of structures (particularly those of reinforced-concrete), of railroads and of hydraulic works. In mechanical engineering the advanced practice is with steam turbines, gas engines and in machine design.

In electrical engineering the graduate courses are largely in advanced alternating current laboratory investigations and in the design of electrical machinery as a continuation of work ordinarily given as "dynamo design." A series of conferences of all graduate students has been arranged to study the contemporary advance in electrical engineering and its relations to historical development. A course has been developed, partly in connection with the Economics Department, on the organization and administration of public service companies.

In the graduate courses in architecture the recommended work is for academic training in designing important and monumental types of buildings; for additional practical training in the design of steel girders and columns, roof trusses and general framing; for additional training in rendering in black and white, in colors and in pencil, architectural studies and perspectives; for studying the landscape gardening of large projects and the intimate relation between architecture and landscape gardening.



Map Showing Cost of Passenger Transportation in New York City, To or From City Hall.

While the fifth-year courses recommended are in general as stated above, they are entirely elective and arranged in major and minor groups. They may be rearranged to meet the needs of each student who may select studies from any of the courses offered provided he has the requisite preparation and the subjects selected form a logical program.

POLICY OF THE INSTITUTE AS AN UNDERGRADUATE SCHOOL.

The following extracts from the remarks of Prof. Noyes may well be said to outline the Institute's policy.

First of all, I believe that it should be clearly recognized that as an independent scientific school one of its main functions is to educate men who have received only a high-school education. It must remain in a large measure a school for undergraduates and must not allow itself to become only a graduate school for the professional training of the former students of other colleges. The question at issue is not which is more advantageous—a professional training preceded by a liberal education or a co-ordination of the two in a single prescribed course—but whether or not there is a large field for the latter type. If ever the demand for this type of education should cease, or if ever it be demonstrated that this type when best developed produces only engineers and scientists of an inferior grade, then will it be time to consider the conversion of this institute into a purely graduate school.

The general principle which should determine the character of our four-year course of study is that a liberal education should be provided such as will develop character, breadth of view and high ideals of service and that the professional education be mainly confined to a thorough training in the principles of the fundamental sciences and in scientific method, specific engineering subjects being included only so far as the remaining time permits and as the minimum requirements of professional service demand. By courageously eliminating from our fourth-year curriculum the more technical branches in instruction, however important they may be for the practicing engineer, and by making ample provision for them in graduate courses we shall make our undergraduate courses more educational in the broadest sense and we shall make more evident to the student the practical importance of returning for a fifth year to acquire the more specialized knowledge of the separate engineering professions. We will give in our four-year course a training which will still enable those students, who are obliged to do so, to enter at once upon the practice of their professions, handicapped somewhat it may be by lack of technical experience, but with a sound knowledge of principles and a developed mental power which will enable them to overcome this disadvantage. We will develop graduate courses of such a character as will obviously remedy this deficiency of insufficient specialization and will attract such graduates of this and other scientific schools as are financially able to continue their education.

The opportunities of the four-year period have, however, not been fully realized. Our summer vacations form one-third of the whole year and during this time most of our younger students are unoccupied or are at work in places from which they derive no educational advantage. The assignment of four or five weeks to those portions of our work, which consist largely in the acquirement of technical skill and experience such as laboratory practice, shop-work, drawing, work in the field and in industrial establishments, would so relieve the present overcrowded curriculum that an amount of good entirely out of proportion to the time gained could be accomplished. The pressure of the school year would be somewhat diminished and the summer work would not continue the mental strain to any great extent.

FIVE-YEAR COURSES FOR THE BACHELOR DEGREE.

In emphasizing the importance of maintaining our undergraduate four-year course, I should be sorry to give the impression that that period is considered a fully adequate one. On the contrary I believe the institute should at once meet the demand for a broader education by a development of a three-year course in general science which should contain, partly as required work and partly as elective, all or nearly all those subjects now included in the first two years of the various courses, so that these courses may be completed in two years more by students who have completed the three-year course. This plan would enable three years instead of two to be devoted to the humanistic branches of study, to the natural sciences and to the fundamental physical sciences. It would provide, in a large measure, the breadth of scholarship which the college course is designed to supply and would do this by the methods and in the atmosphere of the scientific school. Such five-year courses could also make provisions for those conscientious, thoughtful students who have the ability to do our work satisfactorily but cannot do so at the rate and under the pressure which our four-year curriculum involves.

A MAP OF RADIAL TRANSIT IN NEW YORK CITY.

An instructive map recently prepared by the City Club of New York City is reproduced in the drawing herewith. It shows to what extent the transit facilities of New York City are developed and, more important, to what extent they are undeveloped. The map tells at a glance the fare required to reach any particular point of the city from the City Hall (marked by a cross), by outlining the areas reached by fares of 5 cts., 8 cts., 10 cts., 15 cts. and 20 cts. respectively. Those areas which can be reached only by paying higher fares than 20 cts., or reached only by slow or otherwise inconvenient routes, are shown in black. The legend on the map explains this fully.

It must be borne in mind that this map does not tell the whole story, for the reason that there are large suburban areas outside the city limits, reached by the various trunk railways, which are served by low rates of monthly commutation and frequent train service. This includes a large and densely settled area of New Jersey within a distance of 15 miles west of the Hudson River, an equal area in Long Island east of the

city limits, and numerous prosperous suburban towns north and northeast of the city along the lines of the New York Central & Hudson River R. R. and the New York, New Haven & Hartford R. R. The territory in question is much better served, i. e., more conveniently and cheaply accessible, than the southern and central parts of Staten Island (Richmond borough), for example.

Considering the suburban areas outside of the city, however, only strengthens the showing of

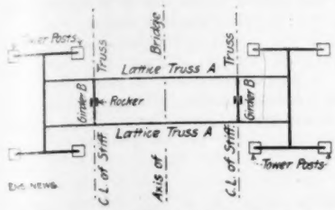


Fig. 1. Diagram Plan of Girder System Transmitting Reactions of Stiffening Trusses to Main Towers, Williamsburgh Bridge.

the map that the city is still very far from having such transit facilities as would develop the urban area to its fullest extent. While the geography of New York City has a large influence on these deficiencies of transit development, yet substantially the same showing would be made by similar maps of other large American cities.

ADDITIONAL SUPPORTS FOR THE STIFFENING TRUSSES OF THE WILLIAMSBURGH BRIDGE, NEW YORK CITY.

A piece of work interesting in both its theoretical and its practical aspects is being carried out on the Williamsburgh Bridge, the second suspension bridge over the East River at New York City and the largest structure of its type in the world. In recent check computations of the weight and strength of the structure, carried on by the city's Department of Bridges, it has been found that the supports of the stiffening trusses at the towers are relatively weaker than other parts. In order to develop maximum-carrying capacity, therefore, it was thought advisable to strengthen these supports. Plans for this

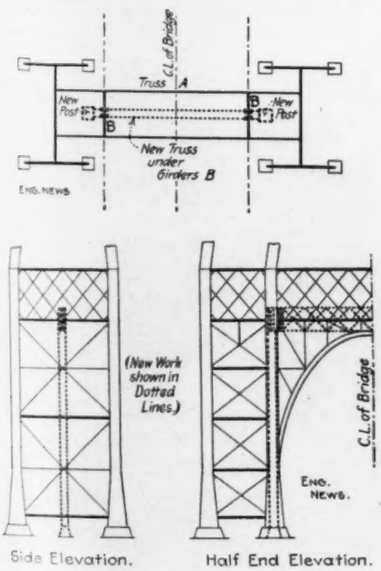


Fig. 2. Sketches Showing Location of New Posts and Girders for Strengthening Rocker Support.

strengthening were developed by the Department and the execution of the work is now in progress.

The undertaking has a special interest, of course, from the fact that the bridge was completed only three years ago, and that its design was worked out with great care by the engineers of the East River Bridge Commission, under Mr. L. L. Buck, M. Am. Soc. C. E. To avoid creating a false impression, therefore, it should be said at once that the main motive for this strengthening is to make the structure able to carry considerably higher loads than contemplated in the original design.

The drawings Figs. 2 and 3 show the location and construction of the reinforcement work. To understand its functions and the reasons for putting it in, however, a brief explanation will be required.

The Williamsburgh Bridge spans 1,600 ft. c. to c. of main towers. It has four cables, but only two stiffening trusses, these latter being spaced 67 ft. on centers. Unlike the arrangement used in the Brooklyn Bridge, the backstays or land spans of the cables are unloaded, i. e., the land spans of the roadway, 596 ft. 6 ins. long, are not hung to the cables but are carried by independent truss spans. About halfway between the anchorage abutment and the main tower, on either shore, there is a trestle bent to support these shore spans. The span from the abutment to this bent projects beyond it, forming a cantilever arm 59 ft. long. Similarly the stiffening trusses of the main span extend a short distance beyond either main tower, forming a cantilever arm of 23 ft. 6 ins. on the land side of the tower. The cantilever arms at intermediate bent and main tower are connected by a truss span of 217 ft. 5¾ ins., resting on the pins at the ends of the cantilever arms. Thus, the truss system is divided as follows, from one anchorage to the other: Anchorage span, Connecting span, Main span, Connecting span, Anchorage span. The stiffening trusses of the main span are continuous between the connecting spans, i. e., they have no intermediate hinges.

The stiffening trusses are carried by the cables by means of hangers (each truss being hung from two cables), and in addition bear on rocker supports at the main towers. The dead load between towers is carried by the cable hangers, so that the chief work of the rockers is to carry the end reaction coming from the adjoining connecting span, and a part of the live load on the near half of the main span. Temperature changes do not affect the loads on the rockers materially, as the main towers are of steel construction, and in consequence their expansion counterbalances the expansion of the hanger ropes.

The means by which the rockers transmit their loads to the towers are sketched in Fig. 1. This is a diagrammatic plan at one tower just below the roadway of the bridge; it is not a complete plan, only those girders being shown which carry the vertical load of the rockers. The bottom chord of the stiffening truss is some 10 ft. above plate-girder B. The rocker is a double-channel strut 11 ft. 3¼ ins. long, set vertically between truss and girder and engaging pins set in bearing castings in each. It has a cross-section area of about 165 sq. ins., or the two rockers at each main tower have an area of 330 sq. ins. The rocker load is transmitted by plate-girders B, 8 ft. 10 ins. deep, to the transverse lattice trusses A, and thence by longitudinal and cross girders in the faces of the towers, as shown, to the eight legs of the tower. In the same plane as these girders there is also a set of bracing which transfers the wind loads from the lateral system of the stiffening trusses to the towers; a vertical pin set in a block sliding in longitudinal guides connects the lateral system to this bracing without affecting the free longitudinal expansion. This is shown by a drawing given in our issue of April 18, 1901, p. 290.

The original design for the bridge was based on a working live-load of 4,500 lbs. per lin. ft. for the stiffening trusses and 5,700 lbs. per lin ft. for the cables. Ten years ago, when the bridge was designed, these loadings appeared ample, but later practice has made this loading seem lower than desirable. It was accordingly decided to study the bridge in detail to determine its live-load capacity on the basis of the maximum unit-stresses permissible. This study showed that a working live-load of 6,800 lbs. per ft. of bridge, or an emergency or "congested" live-load twice as great (this latter with unit-stresses limited only by the elastic limit of the material), does not in general exceed the strength of the cables, stiffening trusses and towers. The rockers, however, and some parts of the supporting girder system, are considerably overstressed by this loading. The relative weakness of these elements is chargeable in part to the fact that the weight of the connecting span proved to be greater than was originally assumed, and this weight forms a large part of the dead-load on the rockers.

Of the girders carrying the rocker load, the short plate-girders B and the transverse trusses

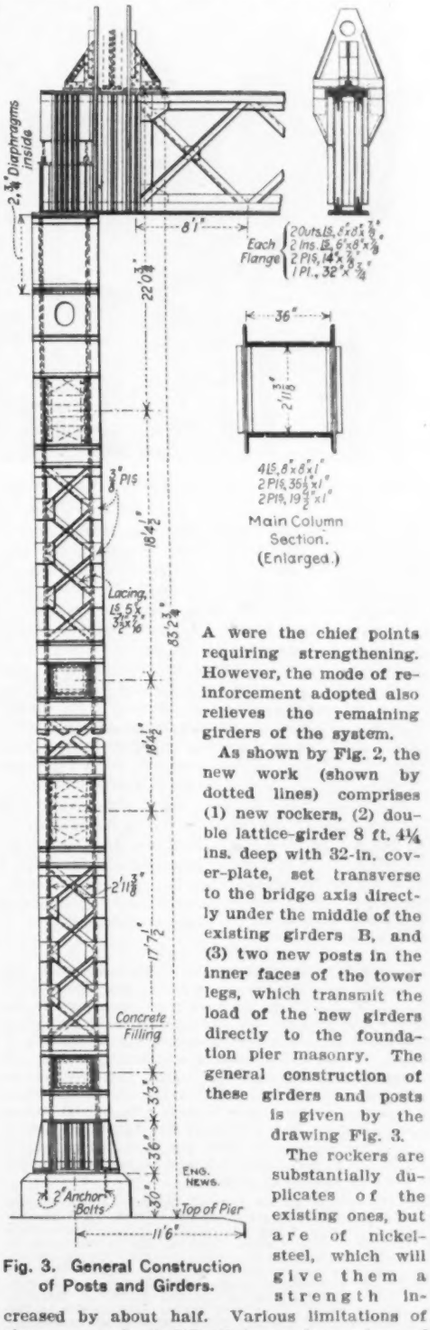


Fig. 3. General Construction of Posts and Girders.

A were the chief points requiring strengthening. However, the mode of reinforcement adopted also relieves the remaining girders of the system.

As shown by Fig. 2, the new work (shown by dotted lines) comprises (1) new rockers, (2) double lattice-girder 8 ft. 4¼ ins. deep with 32-in. cover-plate, set transverse to the bridge axis directly under the middle of the existing girders B, and (3) two new posts in the inner faces of the tower legs, which transmit the load of the new girders directly to the foundation pier masonry. The general construction of these girders and posts is given by the drawing Fig. 3.

The rockers are substantially duplicates of the existing ones, but are of nickel-steel, which will give them a strength increased by about half. Various limitations of clearance made it difficult to employ rockers of larger section, so that resort to a stronger material was necessary.

The connection between rocker and supporting girder has been strengthened for downward loads and also adapted to resist uplift, by the yoke or bracket shown in Fig. 3, which is riveted to stiffener angles of the new girder and projects up to engage the pin at the foot of the rocker. With high intensity of live-load on the bridge, it is possible to have an uplift at the rocker

when the farther end of the main span carries maximum live-load. The old design made no special provision for uplift, the connection of the rocker-pin casting to girder B being very weak against upward pull on the rocker.

The new columns have a built two-channel section, each channel being 36 ins. deep, the two channels being 2 ft. 11⅝ ins. apart in the clear. The area of cross-section of the column is about 172 sq. ins., practically the same as the sectional area of the rocker. The column is braced in one direction by the struts and diagonals of the bracing in the inner face of the tower leg, which passes through between the channels of the column. In the other direction it has no bracing.

When the new posts and girders are in place, it is intended to wedge up the ends of the girders sufficiently to make them assume most of the load which now goes into girders B. This is under present conditions of loading, i. e., under only a small part of the maximum possible live-load. Any live-load coming on subsequently will then divide between the new and the old girders in proportion to their relative stiffness.

The designs for the new work were developed by the regular organization of the Department of Bridges of New York City, Mr. J. W. Stevenson, Commissioner of Bridges, Mr. C. M. Ingersoll, Chief Engineer, and Mr. L. S. Moisseiff, Engineer. The work is being done by J. H. Gray & Co., of New York City, under contract.

COUNTY BACTERIOLOGICAL LABORATORIES are authorized in a bill introduced in the New York Legislature. The bill is in the form of an amendment to the county law (Chapter 686, Laws of 1892) and authorizes the Board of Supervisors of any county to establish a county laboratory, and "appoint a thoroughly trained and competent county bacteriologist" and "such assistants as may be required"; or, where no county bacteriologist is appointed, contracts may be made with counties having such to perform such services as may be deemed "necessary in the interests of public health." Any and all of the county bacteriological laboratories established under this act or already in existence

shall be subject to the general supervision and inspection of the State Commissioner of Health, shall furnish copies of reports of examinations and investigations made by it to the State Commissioner of Health whenever he may deem it advisable or in the interests of public health, and shall co-operate with the State Commissioner of Health and the State Hygienic Laboratory in the suppression and control of contagious and infectious diseases. All equipments used in such county laboratories in the collection of specimens, for the diagnosis of contagious and infectious diseases, and in the analysis of water supplies, shall be furnished by the State Commissioner of Health and the expense thereof shall be audited and paid as other expenses of the Department of Health are authorized by law to be audited and paid.

It appears from the monthly Bulletin of the New York State Department of Health for February, 1908, from which the foregoing information has been taken, that one or two county laboratories have already been established in the State and that the proposed bill is designed to avoid the necessity of special bills whenever other counties wish to join the list of those having laboratories.

A GASOLINE MACHINE FOR DRILLING RAILWAY TRACK WORK.

The application of machinery to railway track work has been developed to but a very small extent, although there is a good field for such development. In former issues we have described a manual machine for boring spike holes and driving screw spikes, a French electrically operated machine for similar work and for tamping ties, and the use of electric augers and wrenches for putting in screw spikes on the Chicago City Ry. Limited use has also been made of a rail-drilling machine consisting of a car equipped with a steam-driven air-compressing plant and pneumatic drills. Electricity is rarely available on railways, and only in exceptional cases would it be economical to employ a locomotive and drilling car. An interesting adaptation of the type of gasoline car now extensively used by railway section and bridge gangs to this class of track work has been made recently by Mr. H. W. Jacobs, Assistant Superintendent of Motive Power of the Atchison, Topeka & Santa Fe Ry., Topeka, Kan., and particulars of this have been furnished us by Mr. Jacobs. The machine, which is styled the Autrakar, is being manufactured by the Tool & Railway Specialty Mfg. Co., of Atchison, Kan.

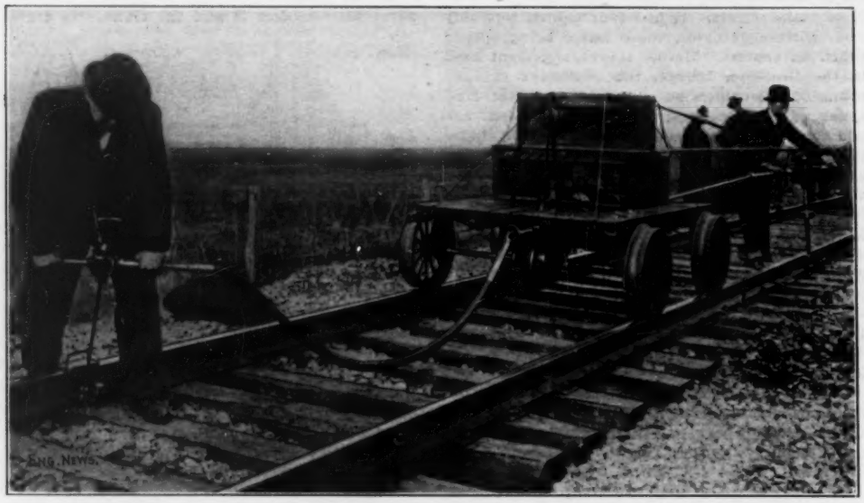


FIG. 1. DRILLING SPIKE HOLES AND PUTTING IN SPIKES WITH THE "AUTRAKAR"; ATCHISON, TOPEKA & SANTA FE RY.

It will be seen from the accompanying cuts that the machine resembles a gasoline section car, but the engine operates shafts which extend to both ends of the car and are equipped with universal joints for connection to flexible or telescopic shafts which transmit the power to the track tools. The machine has given very good results in applying screw spikes. In oak ties, the holes are drilled in from 5 to 10 seconds, and the spikes screwed home in about 20 seconds. The first machine operated only one drill (in front of the car) and one wrench or spike-driver (behind the car). The cars now being built have two spike-drivers, so that rapid and steady progress can be made with one man drilling holes and two men putting in spikes. A jig or template set on the rail has holes to give the proper position for the spike holes. The spike driver has bevel reversing gear and spur reducing gear, which latter reduces the speed from 7[illegible] to 24 r. p. m. It may be fitted with releasi[illegible]device which will automatically release or d[illegible]nnect the driving wrench when the spike is [illegible]ewed firmly upon the rail. Screw spikes a[illegible] to be placed in this way on eight miles of tr[illegible].

Fig. 1 is a view of the machine, with t[illegible] auger and jig in front (at the left) and th[illegible] spike-driver in the rear. It is stated that [illegible] man can drill nine holes by power while on[illegible]le is being drilled by a hand auger, and that [illegible]e can drive five spikes while two men are dri[illegible]g one spike with a cross-handled socket wren[illegible]. Fig. 2 shows the machine operating a rail [illegible]. It can also be used to operate rail saws, [illegible]d to drive a small generator or air-compr[illegible]r for use in connection with electric or pneuma[illegible] tools for track work or bridge work. The ma[illegible]ine is light enough to be put on and off the t[illegible]k by two men. A 12-HP. four-cycle air-co[illegible] gasoline engine is used, and the car is made s[illegible]-propelling by means of a driving chain co[illegible]nection to a sprocket wheel on one of the axles.

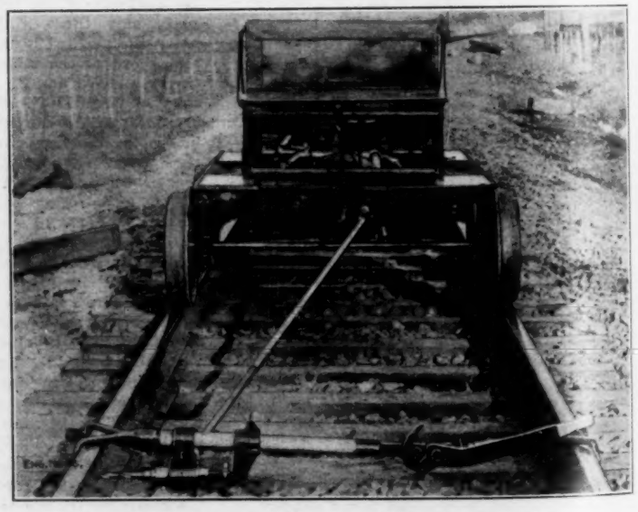


FIG. 2. DRILLING RAILS WITH THE "AUTRAKAR".

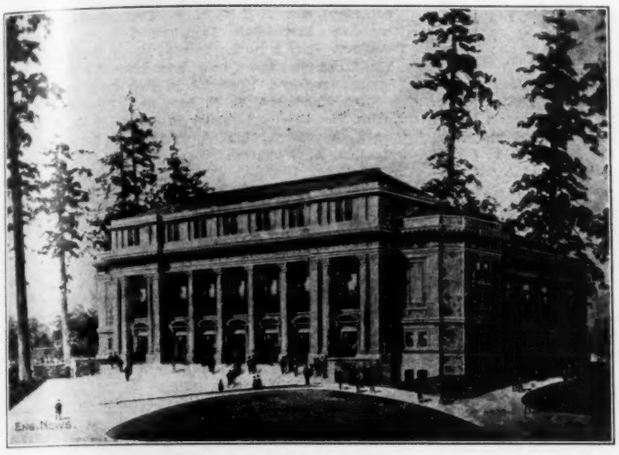
NOTES FROM ENGINEERING SCHOOLS.

UNIVERSITY OF WASHINGTON.—The Board of Regents has awarded contracts for the construction of an auditorium, a chemistry and an engineering building. All of these are to have buff-brick exteriors, although they differ in construction. The first will be built with a steel and wood interior; the second will have a fireproof construction of steel frame and concrete floors; the third will be of heavy mill construction. These buildings will be used by the Alaska-Yukon-Pacific Exposition at Seattle as an Auditorium, Fine Arts and Machinery Exhibits building respectively. Howard & Galloway, of San Francisco, architects for the exposition, have been retained by the Regents of the University of Washington as architects for these three buildings. We are able to reproduce the architects' perspectives of these structures through the courtesy of Mr. A. H. Markwart, Assoc. M. Am. Soc. C. E., the Seattle representative of Howard & Galloway.

A RAILROAD TO THE LAGUNA DAM has just been completed. The road was built by the Southern Pacific Co. in cooperation with the U. S. Reclamation Service, and extends from a point on the main line near Yuma to the dam, a distance of about 12 miles. The greater part of the new line is built on a dike forming a part of the Yuma Irrigation Project. Prior to the completion of this road, all material for the dam had to be hauled in by teams from Yuma. The railroad will be particularly useful in connection with the efforts which it is proposed to make during the next low water period to close the gap between the two portions of the dam already built from either shore. This very interesting example of constructing a dam on the sandy and gravelly bed of a stream liable to great floods was described in Engineering News of Feb. 27, 1908.

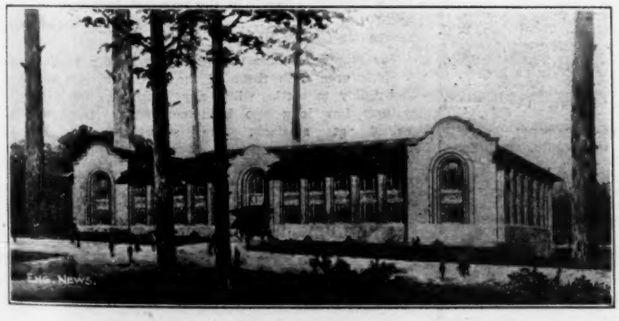
A DEFECTIVE ACETYLENE GAS-PLANT in South Deerfield, Mass., was examined on March 28 by three men, one of whom carried a lighted lantern. The investigation had only commenced when a terrific explosion completely wrecked the plant and killed two of the men outright. The third one died a few hours later from his injuries. The nearby buildings were wrecked and several persons were more or less severely injured.

ANOTHER COAL MINE EXPLOSION must be added to the list of recent mine disasters. On March 28, twenty men were killed in Mine No. 1 of the Union Pacific Coal Co., at Hanna, Wyoming, and while some fifty rescuers were working to save possible survivors of this explosion, a second one brought them a similar fate. Fire had been burning on the tenth level of the mine workings for nearly a week and owing to ineffectual attempts to extinguish it all workings were temporarily abandoned. The superintendent and a crew of the most experienced miners, on the day of the explosion, had gone below to fight the fire. Probably the fire gained on them and exploded an accumulation of gas. After the rescuers, under the direction of a state mine inspector had been at work about six hours the second heavy explosion shut off entrance to the shaft. The entrances to the mine have been closed to smother the flames as it is impossible to fight them at close range.



Auditorium.

Chemistry Building.



Engineering Building.

NEW BUILDINGS FOR THE UNIVERSITY OF WASHINGTON, SEATTLE; TO BE USED BY THE ALASKA-YUKON-PACIFIC EXPOSITION.
(From the architects' perspective drawings.)

A SEVERE EARTHQUAKE in Southwestern Mexico, on March 26, is reported to have entirely destroyed the town of Chilapa and wrought much destruction in neighboring districts. Chilapa, in the State of Guerrero had 10,000 or more inhabitants, was about 115 miles south of Mexico City and 30 miles from Chilpancingo, the state capital, in the Sierra Madre del Sur Mountains. Chilpancingo, a town of about 7,000 inhabitants on the Mexican Central R. R., and the small towns of Conception, Tetilillla, Coatepec, San Jose, San Lorenzo de Moreno, Querenos and Oxatical were more or less badly wrecked. The shocks were severe in Mexico City and were detected at several points in the United States on seismographic apparatus. The loss of life and property in the affected district is expected to be very heavy, although no estimates are available.

THE WORST RAILWAY wreck of the week was on the Erie R. R., near Hornell, N. Y., on March 27, when a westbound Wells-Fargo Express train collided with an eastbound freight. The express, carrying no passengers, was running 45 minutes late with orders to pass the freight at a certain tower and it is reported that the freight train failed to clear the main track in time. The engineer and fireman of the express were killed and four others of both train crews were injured. One man was killed and 19 were injured March 24 in a head-on collision near Burgin, Ky., of the "Blue Grass Special" of the Queen & Crescent R. R. and a special freight. The cause is reported to lie in a confusion of signals carried by a preceding extra freight and in the absence of a night operator at Burgin. On March 24 one man was instantly killed and six more injured at South Memphis, Tenn., in a rear-end collision between a work train and a freight on the Illinois Central R. R. The cause is attributed to a dense fog. At Middletown, N. Y., March 28, one man was killed and four were injured in the head-on collision of a light engine and a way freight on the Lehigh & Hudson R. R. The engineer of the light engine is reported as having tried to gain a certain switch before the freight passed it.

A DYNAMITE EXPLOSION partly wrecked the new bridge across the Raritan River, between Perth Amboy and South Amboy, N. J., on the morning of March 25. This structure is a long 31-span steel bridge, extending, with a 365-ft. swing span, over 3,400 ft. It carries the trains of the Central R. R. of N. J., the Pennsylvania R. R. and the New York & Long Branch R. R. As no explosives had been used in the construction of the bridge, the explosion of March 25 must have been the intentional act of some malicious persons, and frequent labor troubles during the erection have cast some suspicion on former workmen, although no evidence to confirm such suspicion has been found. The bridge was to have been opened within a month, but as the north end of the drawbridge is completely wrecked the date of opening will be set back some months.

THE ABOLITION OF THE CROTON AQUEDUCT Commission, New York City, to take effect on July 1, 1908, is proposed by a bill introduced in the New York Legislature. It is proposed, we understand, to entrust to the New York Board of Water Supply the relatively small amount of work remaining to be done by the Commission.

THE PENNSYLVANIA RAILROAD has just issued the following statement of the mileage under its control:

	Tracks.			Sidings.	Total.
	First.	Second.	Third.	Fourth.	
East of Pittsburg	6,154.63	1,957.96	584.06	467.10	4,624.47 13,788,22
West of Pittsburg	4,925.97	1,283.94	179.22	84.46	3,310.51 9,784.10
Grand total	11,080.60	3,241.90	763.28	551.56	7,934.98 23,572.32

A STUDY OF THE POLLUTION OF LAKE MICHIGAN is advocated by Dr. W. A. Evans, Health Commissioner of Chicago, in a letter to Mayor Busse. Dr. Evans suggests the appointment of a large commission to include representatives of the principal cities on Lake Michigan and of the four states bordering on the lake, together with one representative each from the U. S. Public Health and Marine-Hospital Service and the U. S. War Department.

A LOBNITZ ROCK-BREAKER for submarine rock excavation has been ordered by the Isthmian Canal Commission from Lobnitz & Co., Ltd., of Renfrew, Scotland. It is expected that the breaker, which weighs 15 tons, will be delivered at Colon about Aug. 1, and will be ready for operation before October. A Lobnitz breaker has been in use for a year past by the Empire Engineering Corporation on one of its New York barge canal contracts; but no statement of the results of its operations has ever been obtainable.

A FREIGHT RATE of 15 cts. per ton-mile, or $8 per ton, for a distance of 54 miles has been described by the Interstate Commerce Commission to be a reasonable rate for the transportation of gilsonite over the Uintah Ry. in Utah. The commission says, very properly, that the reasonableness of rates on roads such as that in question must be determined by the financial return which they produce rather than by comparison with rates in effect elsewhere.

A GASOLINE-ELECTRIC CAR, the "Irene," has been built for the Strang Gas-Electric Car Co., of 15 Wall St., New York City, by the J. G. Brill Co., of Philadelphia. The car was built to make exhibition trips on the railways east of the Mississippi with a view of interesting the officials of branch and feeder lines. The car has a seating capacity of 75 and is made of steel except for the interior finish. The Strang system of gasoline-electric car operation was outlined in Engineering News, March 8, 1906.

THE PROPOSED MOUNTAIN VIEW RESERVOIR, to provide storage for municipal water supplies in Essex and other counties in southeastern New Jersey and to prevent floods on the Lower Passaic, is the subject of a special report by the New Jersey State Water-Supply Commission. As between the Mountain View site recommended by the Passaic River Flood District Commission, and the proposed Lake Passaic to be formed by a dam at Little Falls suggested by the New Jersey Geological Survey (Mr. C. C. Vermeule, Consulting Engineer), the Water-Supply Commission recommends the former. It is supported in this by Mr. G. H. Benzenberg, Past President of the American Society of Civil Engineers, of Milwaukee, and Messrs. F. H. Newell and A. P. Davis, M.'s Am. Soc. C. E., Director and Chief Engineer, respectively, of the U. S. Reclamation Service. A dam across the Passaic River at Little Falls, impounding water at a normal-flow line of 186.5 ft. above sea level, or one across the Pompton River at Mountain View at Elev. 203, would store water enough to supply approximately 200,000,000 gals. per day for municipal purposes. Besides this, the Little Falls Reservoir would make it possible to send 100,000,000 gals. per day down the Lower Passaic, and the Mountain View Reservoir would make available for increasing the river flow 50,000,000 gals. per day, "to be used," according to Mr. Benzenberg, "with the ordinary flow of like amount from the Upper Passaic River." A great difference between the two projects is that the dam at Little Falls would flood 27,850 acres at extreme low stage, and 30,200 at the normal level 4 ft. higher, or Elev. 186.5; whereas the Mountain View dam would flood 6,230 acres at low stage and 8,500 acres with the water standing 13 ft. higher, or at Elev. 203. No less than 2,000 acres of the so-called Lake Passaic would be covered with less than 3 ft. of water, and 23% of the whole area would have a water depth of less than 10 ft. In contrast, not more than 1,500 acres of the other reservoir would have water with a depth of less than 10 ft. Mr. Benzenberg says this difference in shallow flow is greatly in favor of the Mountain View dam. In case it should ever become desirable to have more storage than would be afforded by the Mountain View dam, the dam at the lower site could be built, provided it was left for construction last. The report by Messrs. Newell and Davis does not go into much detail, but in general its conclusions are similar to those of Mr. Benzenberg. The estimated cost of the Mountain View Reservoir, as made up not long ago by the Passaic River Flood District Commis-

sion, is $7,438,000, including an allowance of 25% for contingencies. Considerably over $2,000,000 of this sum is for the relocation of highways, railways, a canal, and the Newark water-supply conduits, the latter alone accounting for $1,176,000. Mr. Morris R. Sherrerd, M. Am. Soc. C. E., City Hall, Newark, N. J., is Consulting Engineer to the New Jersey Water-Supply Commission.

THE CONSTRUCTION OF THE BRONX VALLEY sewer from White Plains through a number of small municipalities and Mount Vernon, and thence westward through a tunnel to the Hudson River in Yonkers, is reported as having been begun. Mr. George R. Byrne, of White Plains, is Chief Engineer, and the Mack Paving & Construction Co., of Philadelphia, is the contractor.

A PASSAIC RIVER WATER SUPPLY DISTRICT is proposed by a bill drawn for presentation to the New Jersey Legislature. The object of the bill is to put in motion machinery for flood prevention on the lower Passaic, and at the same time for water conservation for municipal use and water power. The district would include all of Essex County, the cities of Paterson and Passaic and a number of townships in Passaic County, and, in addition, a number of towns and townships in other counties which would be benefited by the proposed works. The bill is really supplementary to a legislative act approved June 17, 1907, which authorizes the State Water Supply Commission of New Jersey to build reservoirs and accessory works for the benefit of any water supply district subsequently established by the Legislature. Under the act named, the commission would issue bonds to pay for the works, and would be authorized to sell water and water power, and to sell or lease shore privileges around the reservoir. The revenues so derived would be applicable (1) to the maintenance of the works; (2) to payment of interest on the bonds; (3) to a sinking fund; and (4) the balance, if any, would be turned into the State treasury. Pending the receipt of an income, the interest on the bonds would be met from the State treasury. The act does not state how the other expenses of the commission, incurred for these works, would be met pending the realization of an income or in case of any deficiency in income. Mr. Morris R. Sherrerd, M. Am. Soc. C. E., City Hall, Newark, is Consulting Engineer of the State Water Supply Commission.

DRY-AIR BLAST is to be applied by the Tennessee Coal, Iron & Railroad Co. to its Ensley, Ala., blast-furnaces. Plans are being developed for a 1,600-ton refrigerating installation, including eight 200-ton ammonia compressors driven by gas-engine power.

PERSONALS.

Mr. Dugald Clerk, Mem. Inst. C. E., has been elected President of the (British) Incorporated Institution of Automobile Engineers.

Messrs. Trimble & Miller, of Pittsburg, Pa., have been appointed Borough Engineers of Aliquippa, Pa., to prepare plans for borough improvements.

Mr. Frederick R. Cooper, Superintendent of Motive Power of the Lackawanna Steel Co., has resigned to take a similar position with the Kansas City Southern Ry.

Mr. Arthur Brown, Mem. Inst. C. E., City Engineer of Nottingham, England, was presented, on March 12, with a silver rose-bowl in celebration of his completion of 40 years' service under the corporation, for 27 of which he has been city engineer.

The engagement has been announced of Col. Washington A. Roebling, of Trenton, N. J., to Mrs. Corinne Farrow, of Charlestown, S. C. Col. Roebling is well known as the builder of the Brooklyn Bridge, New York City. He is 73 years of age.

Professor Ernest Rutherford, formerly professor of physics at McGill University, Montreal, P. Q., now at Victoria University, Manchester, England, has been awarded a prize of 9,600 lire (about $1,800) by the Turin Academy of Sciences for his research work with radio-active materials.

Mr. Charles W. Sherman, M. Am. Soc. C. E., has been elected a member of the Water Board of Belmont, Mass. Mr. Sherman was for many years connected with the Engineering Department of the Metropolitan Water Board, and is now with Metcalf & Eddy, Consulting Engineers, of Boston.

The following cadets, graduated from the United States Military Academy, have been commissioned Second Lieutenants in the Corps of Engineers, U. S. Army (unassigned): Glen E. Edgerton, Charles L. Hall, Virgil L. Peterson, George R. Goethals, John W. N. Schulz, Clarence L. Sturdevant, Earl J. Atkisson, Richard T. Coiner, Robert S. A. Dougherty.

Mr. W. W. Ewing, who has been in charge of the construction of a new plant for the Chicago Railway Equipment Co., Chicago, by Westinghouse, Church, Kerr & Co., has returned to New York City with headquarters at 10 Bridge St. While in Chicago Mr. Ewing was presented, by the Chicago Railway Equipment Co., with a silver loving cup in acknowledgment of his services.

Mr. John Bermingham, Jr., M. Am. Soc. M. E., has resigned as Superintendent of The California Powder Works, of the Du Pont de Nemours Co., at Pinole, California. Mr. Bermingham is reputed to be one of the most expert and daring men in the country in the use of high explosives and during the San Francisco fire, he led some of the attempts to check the flames by wholesale dynamiting.

Mr. George S. Walter, late chief structural engineer for the Arnold Company of Chicago, has become associated with the Chicago organization of the General Fireproofing Company of Youngstown, Ohio. He will represent the concrete reinforcement department and will have headquarters in Chicago. Previous to his connection with the Arnold Company, Mr. Walter was on the American Bridge Company's engineering force.

Obituary.

Capt. Thomas H. Barrett, U. S. N. (retired), died on March 28 at his home in Yonkers, N. Y., after a week's illness. He was born in Baltimore in 1835 and came to New York in 1872. During the Civil War he served in the navy and he has been a chief engineer on Pacific mail steamships and on Atlantic liners.

John A. Brill, son of the founder of the J. G. Brill Co., car builders, Philadelphia, Pa., died at his home in that city on March 25. The J. G. Brill Co., of which he was Vice-President, was founded by John G. Brill, a native of Cassel, Germany, and his son George Martin Brill. At the death, in 1888, of the former, the business passed to the hands of the three sons, of whom John A. Brill was the second. This concern is now one of the largest builders of street railway cars in the country.

Mr. George I. Bailey, M. Am. Soc. C. E., a consulting engineer and contractor of New York City, died suddenly of heart trouble in Yonkers, N. Y., on March 28. Mr. Bailey was superintendent of water-works at Albany, N. Y., during the construction of the water filtration plant there, completed in 1899. For a number of years past he had lived in New York and had been engaged principally in contracting work. At the time of his death, we understand, he was supervising a contract held by him for the extension of a water filtration plant forming a part of the water-works of Yonkers, N. Y. Mr. Bailey was born in 1861. From 1880 to the time of his admission to membership in the American Society of Civil Engineers, in 1890, he was employed by the department of the State Engineer and Surveyor of New York. There he advanced through minor positions until in 1887 he was appointed Assistant Engineer.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN RAILWAY ASSOCIATION.
April 22, 1908. Semi-annual session at New York City. Secy., W. F. Allen, 24 Park Place, New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 1-2, 1908. Annual meeting at Albany, N. Y., Secy., Joseph W. Richards Lehigh University, South Bethlehem, Pa.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-16, 1908. Annual meeting at Washington, D. C. Secy., John M. Diven, 14 George St., Charleston, S. C.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 19-22. Annual convention at Chicago. Secy., W. W. Freeman, 29 West 39th St., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 26-28. Annual meeting at Chicago. Secy., W. H. Merrill, Jr., 382 Ohio St., Chicago.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 9-11. Annual convention at Toronto, Ont. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 22-24. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26, 1908. Annual convention at Denver, Colo. Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26, 1908. Annual convention at Detroit, Mich. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 23-27, 1908. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 29-July 2. Annual convention at Atlantic City, N. J. Secy., Ralph W. Pope, 33 West 39th St., N. Y.

ENGINEERS' CLUB OF BALTIMORE.—The next meeting will be held at the club rooms, Charles and Pleasant Sts., on Saturday, April 11, at 8.15 p. m. Mr. Chas. E. Phelps, Jr., Assoc. Am. Inst. E. E., Chief Engineer of the Electrical Commission of Baltimore, will present a paper on "Fuel Combustion."

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The regular monthly meeting will be held at 29 W. 39th St., New York City. The general subject will be on "The Conservation of Natural Resources." The meeting will be addressed by four speakers, one of whom, Dr. H. S. Pritchett, President of The Carnegie Foundation, will discuss "The Relation of the Engineer to the Body Politic."

AMERICAN ELECTROCHEMICAL SOCIETY.—The following program has been announced for the meeting to be held in Albany, N. Y., April 30 to May 2:

Thursday, April 30 (Hotel Ten Eyck), 10:00 a. m.—Professional session; 2 p. m., Business meeting followed by professional session; 8 p. m., smoker.

Friday, May 1, 10 a. m.—Professional session at Union College, Schenectady. 1 p. m., lunch at works of General Electric Co.; 2 to 6 p. m., inspection of General Electric works; 7.30 p. m., informal dinner at Hotel Ten Eyck, Albany.

Saturday, May 2, 9.30 a. m.—Professional session at Rensselaer Polytechnic Institute; 1 p. m., lunch at Rensselaer Inn; 2 p. m., trolley trip to Saratoga.

The following papers have been promised for the professional sessions: Corrosion of Iron from the Electrochemical Standpoint, C. F. Burgess, University of Wisconsin; The Electrochemistry of Light, W. D. Bancroft, Cornell University; Mercury Cathodes in Nitric Acid Solutions, J. A. Wilkinson; Copper Anodes in Chloride Solutions, Paul Dyshman; Conduction in Electrolytes, L. Kahlenberg, University of Wisconsin; The Potential of the Nickel Electrode, E. P. Schoch, University of Texas; Solubility Determinations in Aqueous Alcoholic Solutions, A. Seidell; Industrial Applications of Aluminum, E. Blough; Power for Electrochemical Industries, John Meyer, Philadelphia Electric Co.; Electrical Conductivity of Graphite, W. Acheson Smith; Distillation of Turpentine in an Electric Furnace, F. S. Snyder; Mathematics of the Induction Furnace; E. F. Roeber, "Electrochemical and Metallurgical Industry"; The Synthesis of Hydrocyanic Acid in the Electric Furnace, R. S. Hutton, Manchester, England.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the Society's rooms in Chicago, on March 25, Mr. J. N. Darling presented a paper on "The Reconstruction of the South Side Elevated Ry., of Chicago." This work included the widening of the structure for a third track, the elevation of the structure to allow of putting stations under the tracks and 14 ft. above the alley, and the replacement of two sharp double-track curves (each turning a right angle) with easier three-track curves. The line was originally built with a view to the World's Fair traffic of 1893, the district served being then only thinly inhabited. The rapid development of this district as an important residential section made it necessary to improve the facilities of the line. The new third track is used for express trains northbound in the morning and southbound in the evening. The original line was built on a private right-of-way along the back of lots abutting on an alley. To widen the line it became necessary to utilize the alley, and the city, in granting a franchise for this, required the company to throw open its entire right-of-way (about 40 ft.) as a public thoroughfare and to pave it with asphalt. This necessitated raising the grade at streets where stations were located, in order to put the stations above the new thoroughfare. The original line was from Congress St. to Jackson Park. Extensions have been built north to the terminal loop east to Kenwood and west to Englewood, while an extension west to the stockyards is nearly completed.

The foundations for the new work have a much larger bearing area than those of the old work, and are thus less likely to settle, while any settling of the old foundations has long ago been concluded. Besides being raised at stations, the structure had to be raised to clear the track elevation of the St. Charles Air Line and the Chicago Junction Ry. The raise varied from 3½ ft. to 8 ft. at different points. The raising was done by 30-ton hydraulic jacks, and a cribbing of 12 × 12-in. timbers built up as the work progressed, the cribbing being surmounted by a trestle bent. The traffic was interfered with to only a slight extent, but no trains were allowed to pass until the cribbing was built up, as the jacks could not stand the impact of trains. No jacking was done during the "rush" hours. Single-track sections had to be worked during some stages of the work in changing tracks. At one point, the girders of the structure were shifted laterally, being carried by trestle bents with sills riding on rollers on the cribbing.

In the discussion Mr. Darling explained that the entire work was done by contract, even to the track construction. The results had been eminently satisfactory. Mr. J. F. Storey (A. T. & S. F. Ry.) remarked that most large railways find it preferable to do bridge renewal and erection work by their own forces, but in such cases there is permanent work for the men and the equipment. It would probably not have proved satisfactory for the elevated railway to build up and equip an organization for its work. A peculiar feature of the new profile is the location of stations at the summit of 1% grades; these assist in stopping trains. They are of little assistance in starting, however, as the train is then standing on a level section and the rate of acceleration due to the multiple-unit traction system is very rapid.

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